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TRANSIT

Musk's Hyperloop math doesn't add up

by Matt Johnson • August 14, 2013

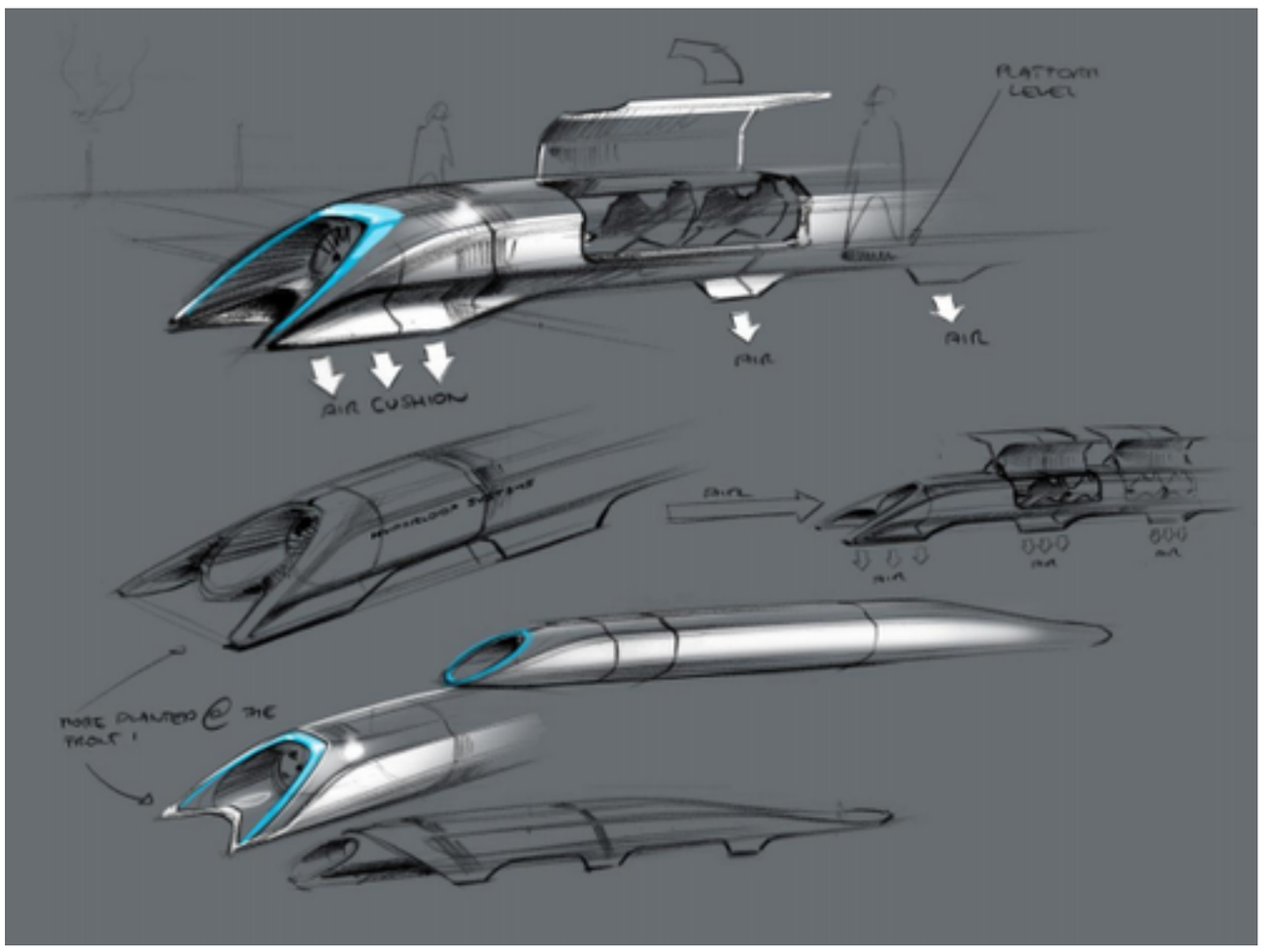
On Monday, entrepreneur Elon Musk announced ~~plans to build~~ a design for a super-fast tube train connecting Los Angeles and San Francisco. He believes his plan will obviate the need for the California High-Speed Rail. Unfortunately, his math doesn't add up.

Photo by the author.

The "Hyperloop" would be a pair of tubes stretching from Los Angeles to the Bay Area. Pods within these tubes would travel at up to 760 mph, making the trip between California's largest metro areas in 35 minutes. Musk says he became motivated to invent this technology because he grew disenchanted with the California High-Speed Rail project's expense ($53 billion in 2013 dollars) and sloth (it will travel at an *average* of 168 mph).

Musk claims the Hyperloop system could be built for just $6 billion, 10% of the cost of HSR. Some are wondering if this is a serious proposal or a ploy intended to derail the California High-Speed Rail project. Evidence seems to point to the latter. After all, the guy proposing this revolution in transit owns a car company.

The Hyperloop concept has gotten a lot of press over the past few days. It seems to have inspired the masses like an idea out of Popular Mechanics. And it may very well be possible to build a system much like this one. Perhaps one day in my lifetime, people will be taking Hyperloops all over the nation.



Hyperloop concept drawings. All images from Musk's proposal.

Let's set aside for the moment any discussion of the technical feasibility of this project. The Hyperloop may very well be something that we have the skills and know-how to build. It may even be desirable in some corridors. But the technological concept is only part of what Musk has proposed.

Musk suggests that for less than 10% of the cost of building the long-planned high-speed rail line between Los Angeles and San Francisco, we can invent and build an entirely new technology. But the Hyperloop doesn't actually make it to downtown LA or downtown San Francisco. It also has a maximum passenger capacity of just 10% of the HSR line. And it bypasses all of the intermediate population centers in central California that HSR will serve.

If it sounds too good to be true, you should probably double-check the math. And the math surrounding the Hyperloop definitely has problems.

Unrealistic promises?

According to Musk, pods would depart LA and San Francisco every 30 seconds during peak periods. Each pod can carry 28 passengers. That means that under the maximum throughput, the Hyperloop is capable of carrying 3,360 passengers each hour in each direction.

For context, a freeway lane can carry 2,000 cars per hour. A subway running at 3 minute headways (like the WMATA Red Line) can carry 36,000 passengers per hour. The California High Speed Rail, which this project is supposed to replace, will have a capacity of 12,000 passengers per hour.

That means that Musk's proposal can carry only 20-25% of the passengers of the California High-Speed Rail under ideal circumstances. But are those ideal circumstances reasonable? Probably not.

The Hyperloop pods will travel at up to 760 miles per hour, just under the speed of sound, with pods traveling about 30 seconds apart in the tube. They will have a maximum deceleration of 0.5 gs, which is equivalent to 10.9 mph per second. At that rate of braking, it will take a pod 68.4 seconds to come to a full stop.

That's a pretty significant issue because safe vehicle operation means never getting closer to the vehicle ahead than the distance it will take you to stop. If pod A were to experience a catastrophic air-skid failure, crash into the tube wall, and disintegrate, pod B, 30 seconds back, would not be able to stop short of the wreckage. In fact, pod C would also likely hit the wreckage of pods A and B.

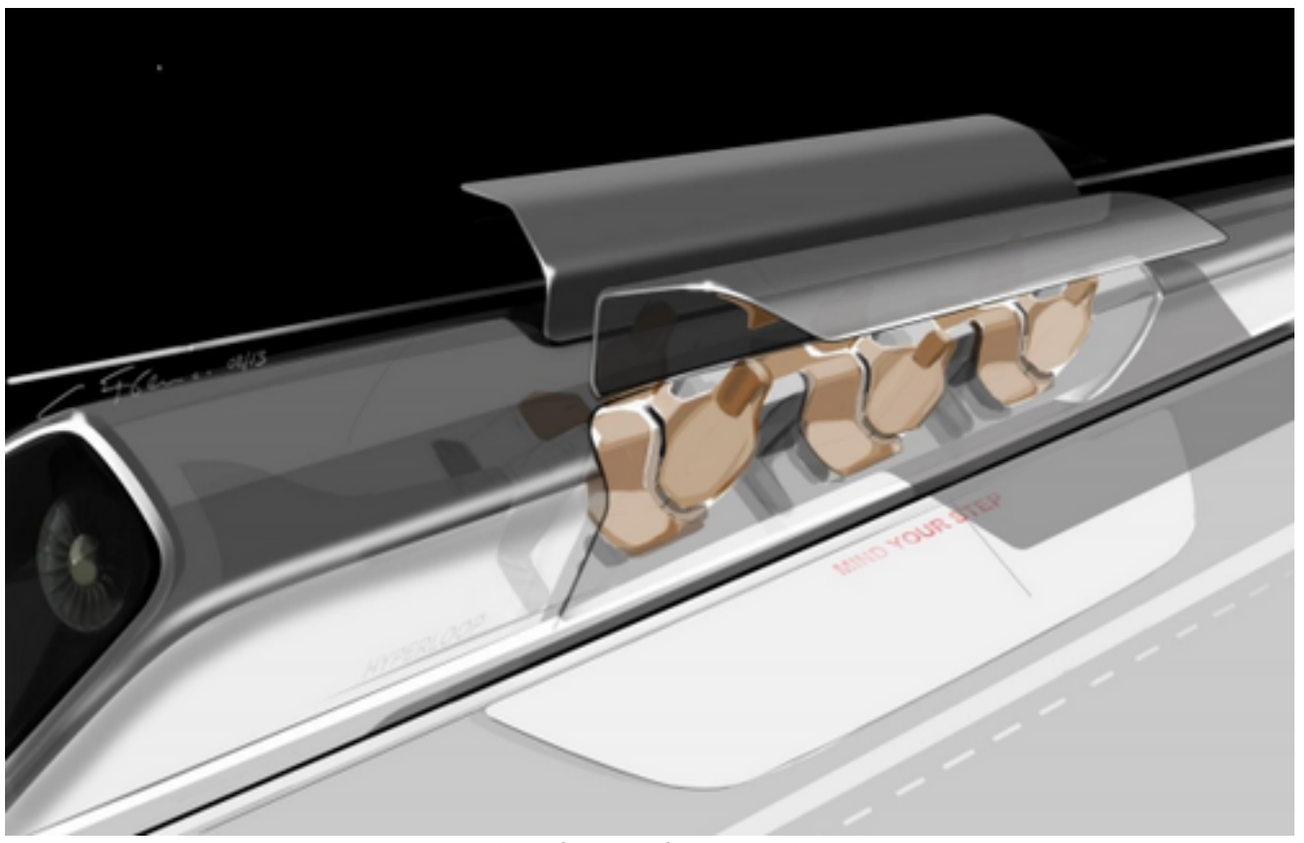
That means that the minimum separation between pods is probably closer to 80 seconds or more. Not a big deal. It still means 45 departures per hour. But that's only 1,260 passengers per hour in capacity. That's 10% of what the California High-Speed Rail can carry.

With a capacity of 1,260 passengers per tube, that means that the Hyperloop would need 10 tubes in each direction (not 1) to move the same number of passengers as the proposed high-speed line. And that would push the cost up by 10, which is actually *more* than the cost of the HSR.

Limitations

The maximum throughput of a transit line equals the throughput of the segment with the least capacity. Simply put, if we have a 2-track railway that has a long single-track segment, the whole line is limited by that section.

The Hyperloop will have chokepoints, too. Because the tubes will be kept at a near-vacuum, each station will have an airlock that trains pass through. Every time a pod arrives, it has to decelerate and stop. Then the airlock will have to close, pressurize, and open again. Then the pod has to clear the airlock. Then the airlock can close, depressurize, and then reopen.



A Hyperloop pod at a station.

All of that has to happen in less than 30 seconds (if Musk is to be believed) or 80 seconds if vehicles are kept a safe distance apart.

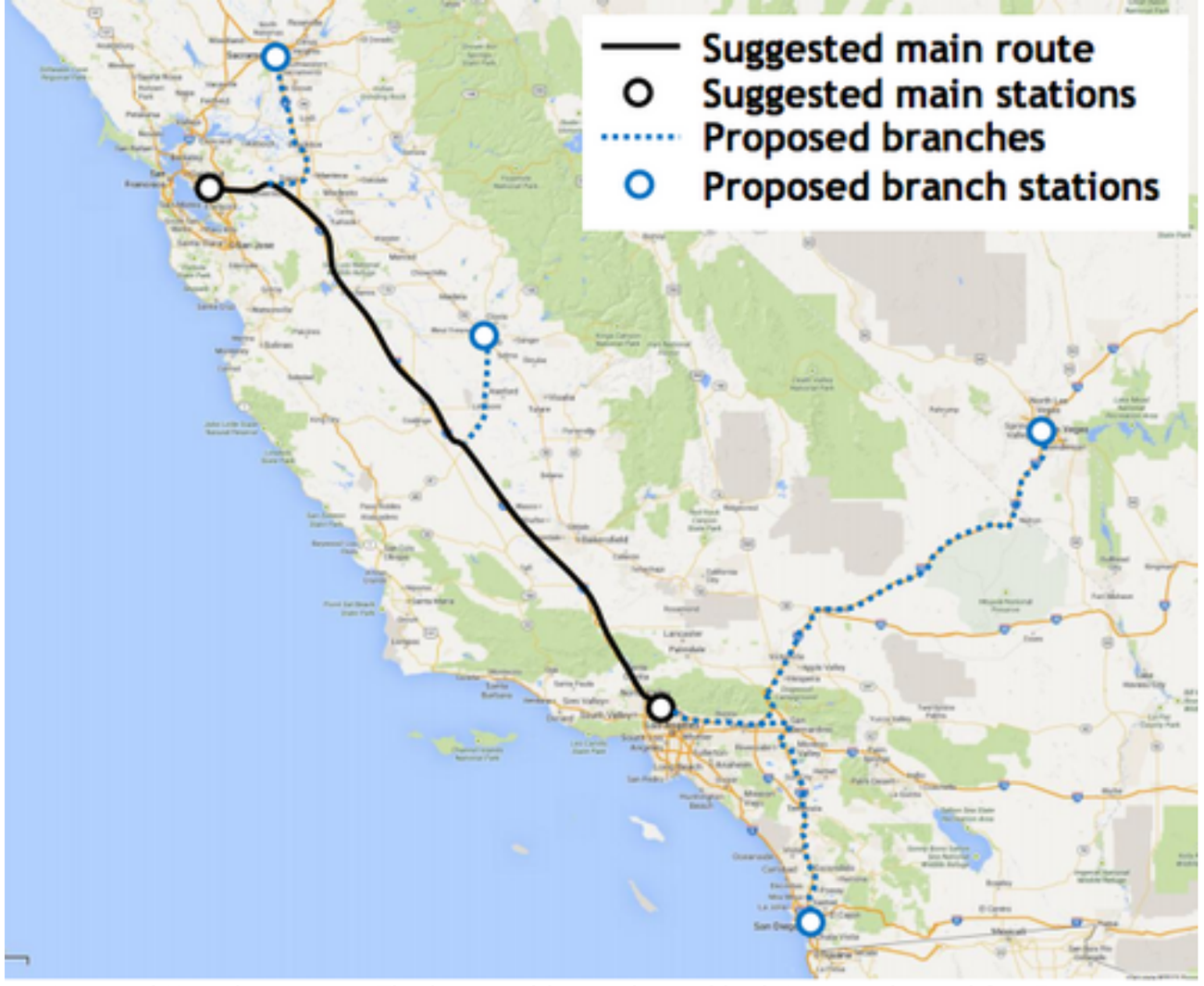
Meanwhile, Musk says that each station can have 3 pods on the platform at once. If pods arrive every 30 seconds, then passengers and baggage have to get off within 60 seconds. One arthritic passenger or a guy who goes back for the iPhone he left behind, and pods start backing up in the tube.

So clearly, Musk needs to rethink headways. The 30-second headway isn't feasible, meaning that his capacity will be significantly lower than he claims.

Maybe he can resolve that by using larger pods. But of course, a larger pod will weigh more. And that will probably mean using stronger steel for the tubes, which means that the cost will go up.

Apples to oranges

The California High-Speed Rail will whisk passengers from Los Angeles Union Station to the Transbay Terminal in downtown San Francisco in 2 hours and 48 minutes. That's too slow for Musk, and he says the Hyperloop can get you from Los Angeles to San Francisco in 35 minutes.



Proposed Hyperloop route. The line would stop short of both Los Angeles and San Francisco.

But the Hyperloop won't start in Los Angeles, and it won't end in San Francisco. Instead, it's proposed to start in Sylmar, 38 minutes north of Los Angeles Union Station aboard the Metrolink commuter train. That means it takes longer to get to the Hyperloop from downtown LA than it would take to go to San Francisco.

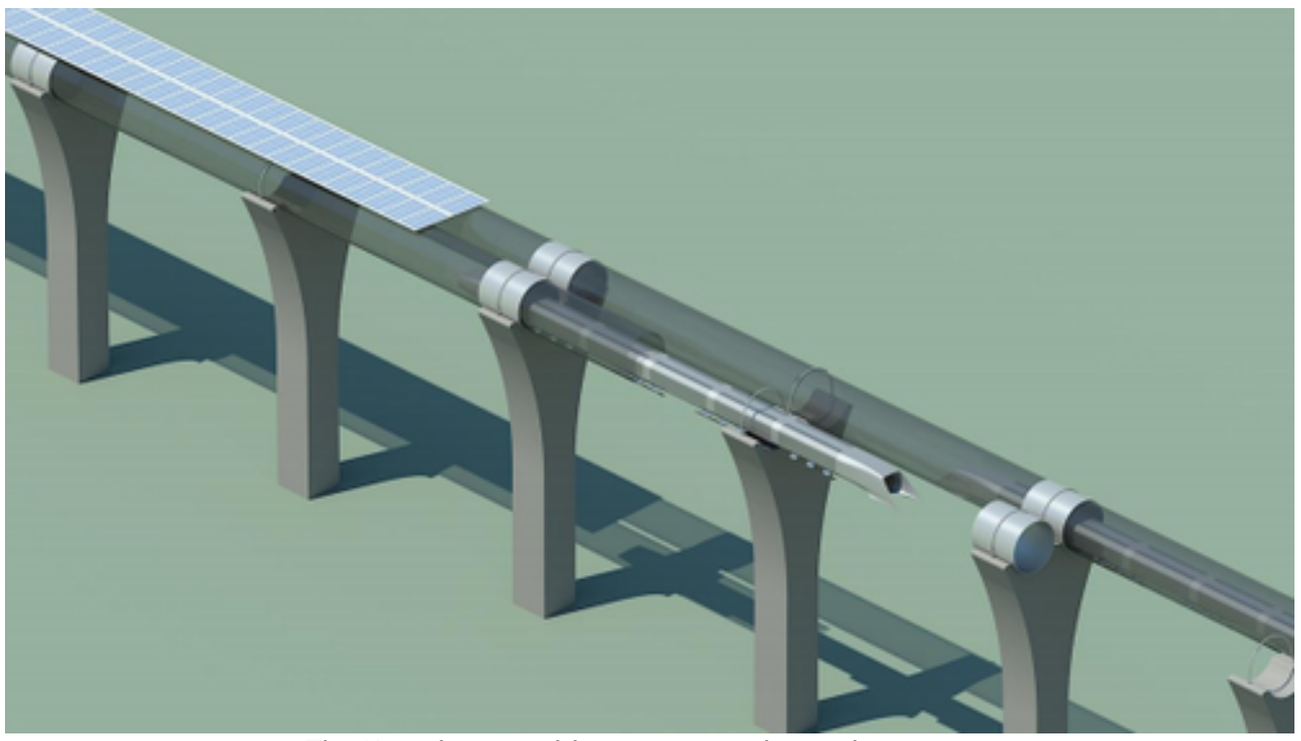
It's unclear where the Hyperloop would end. Some maps show the line crossing the San Francisco Bay either on or adjacent to the Bay Bridge. But his cost projections don't mention the expense of crossing the bay. Other maps show a terminal south of Oakland. So either his Bay Area station will be in the East Bay, requiring a transfer to BART to reach San Francisco, or he's lowballing the cost of the project. The 11-year long effort to rebuild the eastern span of the Bay Bridge has cost $6.3 billion, so another crossing won't be cheap.

Of course, there's nothing technically infeasible about extending the Hyperloop into downtown LA or San Francisco. But it would significantly increase the costs of the project. The California High-Speed Rail's sections in the San Joaquin Valley are also extremely cheap. If the HSR started in Sylmar and ended in Oakland, it would be significantly cheaper, too. While the cost of getting all the way downtown is already factored into the HSR project, it's not part of the Hyperloop proposal.

Conclusions

Musk's proposal won't actually get riders to the downtowns of Los Angeles or San Francisco. It can only carry around 10% of the capacity of the California High-Speed Rail. Additionally, it will bypass other population centers, like Bakersfield, Fresno, and San Jose.

Building a truly workable Hyperloop, if it's feasible at all, will be significantly more expensive than Musk claims. It might even be more expensive than the California HSR project. And Musk's proposal leaves a lot of questions unanswered.


The Hyperloop would run atop an elevated structure.

How did he come to his construction cost estimate in the first place? Musk argues that the Hyperloop is cheaper than HSR because it's elevated, saving on the cost of building at grade and reducing local opposition. But bridges are far more expensive than building tracks at grade. And just because the footprint is limited to a big pylon every 100 feet doesn't mean that the environmental impact analysis process will be any easier or that the public will be any more

receptive.

Other issues, like seismic stability, are simply glossed over. He claims that by elevating the Hyperloop tracks, they will be more stable than ground-running HSR. Clearly he's unfamiliar with the Cypress Street Viaduct. That's one reason that the California High-Speed Rail Authority insists on crossing all faults at grade.

Musk also claims that his giant steel tube will be okay with the only expansion joints at the Los Angeles and San Francisco ends. They'll just be really big. That's a significant engineering issue that cannot simply be ignored, at least not if Musk is in any way serious about this proposal.

Realistically, the Hyperloop is just hype. The concept might be technically feasible. But Mr. Musk's proposal will cost a lot more and do a lot less than he claims it will. And clearly, it won't replace the high-speed rail project he hates so much. But it might just sell some Teslas.

Tags: California, Elon Musk, high-speed rail, Hyperloop, transit

Matt Johnson has lived in the Washington area since 2007. He has a Master's in Planning from the University of Maryland and a BS in Public Policy from Georgia Tech. He lives in Greenbelt. He's a member of the American Institute of Certified Planners. He is a contract employee of the Montgomery County Planning Department. His views are his own and do not represent the opinion of his employer.

Comments

Add a comment »

Mr. Musk's proposal will cost a lot more and do a lot less than he claims it will. And clearly, it won't replace the high-speed rail project he hates so much.

Maybe, but if it were to bankrupt a consortium of investors rather than the entire state of California, it would represent a vast improvement on current HSR plans.

Also worth a read on Mush and Hyperloop is Kevin Roose's commentary for *New York* magazine.

by Bitter Brew on Aug 14, 2013 10:48 am • link • report

Yes - exactly. Its cheaper because its got alot less utility. As you say - if the CA HSR only had to handle 1/10th of the passengers between the suburbs of the two big cities with no intermediate stops, it too would be pretty cheap (since like Hyperloop, it could run on I-5, instead of in the somewhat more expensive land near the cities in the Central Valley.)

And of course even then, I suspect that Musk's projections are really low - considering his technology has never been used, and based on the reality that these projects always cost more in land acquisition, legal fights, planning, etc than expected and take longer (i.e. more expensive future dollars).

I can't really envision a scenario where Hyperloop would be great. For long distances between big population centers you would want the capacity of HSR.

For low population areas, it would seem that planes would work just as well - you spend more on the terminals (airports) and vehicles (planes), but nothing on the intermediate routes (air).

by TomA on Aug 14, 2013 10:50 am • link • report

Thank you for the analysis, Matt. You have much more patience for calling bs as it is than I. I think this episode says more about the press looking for hype and sensationalism than news. This "hyperloop" has all the telltale signs or crankery as PRT. Just like PRT, it's meant to kill an actual rail line that would help millions for the financial gain of the Highway Lobby.

by Cavan on Aug 14, 2013 10:53 am • link • report

Sylmar, seriously? The average Angeleno would need to drive over an hour and pass 1-2 airports along the way. And don't bet on your car being all there when you get back...

by yup yup on Aug 14, 2013 10:56 am • link • report

"[CA HSR] will travel at an average of 168 mph."

Can you show your work on that?

I think that's only true starting in 2029, if everything is completed on time, and you don't count stops. Until then, the average speed is going to be really low and include several transfers, and riding on light rail that goes around 30mph.

by Michael on Aug 14, 2013 10:59 am • link • report

Can we compromise and just build high-speed rail that bypasses Bakersfield and Fresno? Because bypassing Bakersfield and Fresno is, generally speaking, the best policy in any given situation.

by UberMitch on Aug 14, 2013 11:06 am • link • report

MONORAIL!

by Bizzzle on Aug 14, 2013 11:07 am • link • report

Uber

Its hard to win the game without visiting Necropolis.

by VaultDweller on Aug 14, 2013 11:10 am • link • report

Sad but true. The technology is cool, though not exactly new or useful, and the cost estimates are outright lies. I must've spent several hours debating about it on various forums.

by ImThat1Guy on Aug 14, 2013 11:12 am • link • report

Also the route makes no sense; either there's a Bay crossing totally unaccounted for, or that's a weird quirk with the image and it terminates in Castro Valley in the north, and the south terminus is Sylmar. That's at least another 45 minutes by BART/MetroLink to downtown.

by ImThat1Guy on Aug 14, 2013 11:14 am • link • report

@UberMitch: Having HSR to Fresno and Bakersfield is like building HSR between DC and Bowie.

by Michael on Aug 14, 2013 11:17 am • link • report

(the Bay crossing was seen on the Google Earth map, not on the above map. I guess it was just highway that looked like the Hyperloop route, both of which were yellow on the Earth map. Still, Castro Valley/somewhere close? Not even Oakland? lol)

by ImThat1Guy on Aug 14, 2013 11:17 am • link • report

You are being too kind to Musk's Hyperloop proposal. Why would it cost that much less than the CA HSR? Still have to build 100s miles of tracks or tubes, support structures, stations, etc. The concept is out of a Tom Swift novel.

But the CA HSR project attracts a lot of ill-informed attacks and comments. Hope the CA HSR can get built so people will see that a modern HSR system does not lay waste to the land and the economy.

by AlanF on Aug 14, 2013 11:40 am • link • report

So back of the napkin stuff

LA to SF is 381 miles >> 2 million feet

Tube has to be 10 ft across or you could not sit 2 people abreast >> 31ft circumference >>62 million square feet of sheet steel

The tube is going to be 1/4" thick (debatable but it must have some thickness or it wont be able to remain tubeshaped, resist the external pressure[vaccuum inside] support the magnets and itself over an elevated structure)

That makes 1.3 million cubic feet of steel

Which at 500lbs per cubic foot and $.50 a lb is 320 million dollars.

No shaping, installation, processing, just the raw cost of the steel for the tubing.
No land acquisition
No magnets
No money for construction
No solar panels
No support pillars
No stations
No vehicles to ride in the tubes
No additional supports for the tubes

Im guessing 6 billion is a bit low

by Richard B on Aug 14, 2013 11:43 am • link • report

The intermediate stops issue is a huge part of the value, very similar in the flawed comparisons of air travel to train travel. With computer networks, it is understood that the value of a network grows as the square of the number of nodes, most commonly referred to as Metcalfe's Law, because of the growth of the number of possible connections. To first order, the same holds true for transportation networks.

Focusing just on the San Francisco-Los Angeles portion of the planned California HSR, there are 11 stations, which means that this part of the HSR line will serve 55 city pairs, in comparison to the 1 city pair of Hyperloop. That's only 2% of the network value!

by thm on Aug 14, 2013 11:46 am • link • report

Not trying to be hyper-critical, but "obviate" means to "eliminate the need for". So, say "obviate" or "eliminate the need for" but not both.

He believes his plan will obviate the need for the California High-Speed Rail. Unfortunately, his math doesn't add up.

by recyclist on Aug 14, 2013 11:56 am • link • report

If its possible to fork the tube and route the pods, you can have as many airlocks as you want..

by chroz on Aug 14, 2013 11:57 am • link • report

Good article, tho.

by recyclist on Aug 14, 2013 12:01 pm • link • report

@chroz:
Of course it's possible. It's also more expensive.

That's the point. Musk claims he can replace the CAHSR for 10% of the cost. But actually moving the same number of people as the CAHSR means his project will cost 10 times that (the same as or more than CAHSR).

And since he's clearly low-balled the cost of construction, it would likely be even more expensive.

So Musk has bascially created an idea that will cost more and move fewer people to fewer places and not deliver them to city centers.

The hyperloop may be possible. But it won't be cheap or particularly useful, at least not the way Musk has designed it.

by Matt Johnson on Aug 14, 2013 12:03 pm • link • report

@ recycle: Not trying to be meta-hyper-critical, but "obviate the need for" is a generally accepted usage. Per the OED:

'In the sense "to make unnecessary," obviate often appears correctly in the phrase obviate the necessity of or need for. These phrases are not REDUNDANCIES, for the true sense of obviate the necessity is "to prevent the necessity (from arising)," hence to make unnecessary--e.g.: "Not insignificantly, it may also obviate the need for some government tuition aid."'

by Goober on Aug 14, 2013 12:07 pm • link • report

I just wonder how many of the same authors writing breathlessly about the entirely vaporware Hyperloop have or will also be writing articles about how terrible CAHSR is. This reminds me of how some people push the PRT idea as an alternative to transit lines, as if they're at all equivalent.

by Distantantennas on Aug 14, 2013 12:10 pm • link • report

Michael: the average speed is from the CAHSR alternatives analysis; of the major alignment decisions - Tehachapis vs. Tejon and Pacheco vs. Altamont - it is the one with the lowest average speed.

The difference between conventional HSR and fancier-than-HSR systems such as maglev is that HSR can run through at lower speed (though much faster than 30 mph) on legacy tracks. This is what is almost certainly going to be the case in the LA and SF areas. Stringing catenary and modern signals on one segment of Metrolink is cheap. Hyperloop can't do that without building exclusive infrastructure for itself.

by Alon Levy on Aug 14, 2013 12:18 pm • link • report

The Onion nails it http://www.theonion.com/articles/new-superfast-transport-system-powered-by-passenge,33468/ as usual.

by Ben Ford on Aug 14, 2013 12:28 pm • link • report

Richard B: the proposal calls for 0.8-1" thick tube, with an internal diameter of 7.3-11'. Despite all the hype you could read at some places (like the pro-Hyperloop comments on my blog), it's actually fairly heavy and, in addition to the cost of raw materials, the cost of putting up the viaduct structures to support the tube would be comparable to the cost of HSR viaducts. That's 10 times as high as the cost claimed in the proposal.

by Alon Levy on Aug 14, 2013 12:47 pm • link • report

The fact is that this nation as a whole should have inter and intra city mass transit infrastructure for a variety of really good reasons (speed, oil prices, environmental concerns, convenience, etc.).

This means an INVESTMENT on the part of GOVERNMENT (read: We the People) to build that infrastructure in the same way that the Eisenhower Interstate System was built. We can't and shouldn't wait for a for-profit entity to lead the way. Too much is at stake for our future generations.

That said, we need to concentrate first on the routes that people actually want to go. So why, in the name of god, is the first planned route from LA heading to Fresno? I'm sure that some people go there, but to build public excitement and attract funding, why not build a train or hyper loop from LA to Vegas? Route 15 is always busy and too crowded to and from LA to Vegas and flights are a pain in the butt and expensive. Build a way for people to park their cars close to home, hop on a train or tube and be in Vegas in comfort and you have instant public backing of mass transit. And, the pathway to Vegas from LA is relatively unpopulated so there won't be many issues with bothering existing neighborhoods and towns on the way.

by Brian Dzyak on Aug 14, 2013 12:54 pm • link • report

Matt, I think your last line hits the nail on the head. Musk is not trying to build a hyper-loop (he says so himself). But he does have three businesses he's actively working with and each of them get heavily promoted here.

1. Solar City - How do you run a hyperloop? Solar Power
2. SpaceX - He's competing for a NASA contract to send passengers to the Space Station and his company kind of depends on it. Anything he can do to look smart and visionary helps with that.
3. Tesla - He's got cars to sell and this provides free publicity.

As a promotional stunt, it's pretty clever (and I think the biographers will make this point 10-20 years down the road) but as a real engineering solution - thumbs down.

by David C on Aug 14, 2013 1:01 pm • link • report

"They will have a maximum deceleration of 0.5 gs,"

That part of your analysis is totally off. That's the normal deceleration when coming into a station. It has nothing to do with how quickly it could brake in an emergency. Coming into a station it uses electromagnetic braking. In an emergency it turns off the airflow and uses normal friction brakes. Stopping in the distance proposed between capsules wouldn't require excessive g forces.

Other criticisms are valid, however.

by gregincal on Aug 14, 2013 1:04 pm • link • report

I understand the criticisms of the proposal and not believing the numbers presented, but I don't understand the attacks on Musk.

by jh on Aug 14, 2013 1:05 pm • link • report

@Chroz In Soviet Russia, tube fork you!

Sorry. I couldn't help myself.

by JohnB on Aug 14, 2013 1:09 pm • link • report

Mightn't this technology make sense for something like a Dulles-DCA-BWI-Dulles shuttle?

by Charles on Aug 14, 2013 1:10 pm • link • report

Arguing against the Hyperloop based on the relative capacities Hyperloop vs HSR is specious at best.

Does anyone seriously think that the HSR is going to operate at anything close to capacity? Really? All the time? Really?

In contrast, the far greater speed (and far shorter trip) on the Hyperloop will be a huge demand driver and will attract riders that the HSR at its current speed has no chance of attracting. I don't think they will have any trouble filling up most of their "carriages" (or whatever they are calling them) and maxing out the capacity of the system.

More generally, given the size of the carriages in the Hyperloop and the speed of the trip the Hyperloop has the option of only sending passengers when there is demand.

And, since the least occupied a carriage can be is something like 10% (if the capacity is ten), the Hyperloop can make money by sending carriages along with far greater frequency that HSR.

In contrast, an HSR train has to go even if it is only 1/1000 full and the journey takes some three or fours. Net net, the Hyperloop is far more able to match marginal cost to marginal revenue.

As for Metcalfe's law, at the speed of the hyperloop the network effect becomes much less relevant. My guess is that there will be enough people wanting to go just between SF and LA (see speed-driven demand above) that you won't need more stations to make the system profitable.

Finally, having lived in Europe for a number of years (and having just missed the opening of the AVE between Barcelona and Madrid) I'm sympathetic to the high-speed rail idea. But, by many accounts outside of the new urbanist / pro TOD community, there is a strong economic case that it's a disaster in the making.

H.D.

by Hill Dude on Aug 14, 2013 1:17 pm • link • report

@Alon Levy: The ability of the tube to span between pylons without support is key to the proposal. The authors are engineers who did the math and chose the pylon spacing and tube design to accomplish this requirement. It's quite possible that their analysis is flawed, but I don't find "it's actually fairly heavy" to be a convincing rebuttal.

by gregincal on Aug 14, 2013 1:17 pm • link • report

@Brian - there were plans to build an HSR from the LA desert exurbs to LV - the government loan is on hold (nominally due to the company not following Buy American provisions).

I'm not sure what the problem is with the CASHR going from LA to Fresno. Among other things - its in the middle. Its the cheap part. It allows them to work out some of the kinks before they start having to build through dense neighborhoods, or tunneling through mountains.

But mostly the first reason - they only have so much money. Not enough to build the LA to Bakersfield or SF to Fresno.

by TomA on Aug 14, 2013 1:18 pm • link • report

Back of the Envelope Guys:

Nice work, Alon Levy and Richard B. My only thought is that I'm not sure if the tube is going to be steel. Could it possibly be concrete?

I'm also not totally convinced that building above ground solves right of way issues. Visually, this thing is going to be pretty bad; a big concrete tube twenty feet in the air? Also, sound wise, I don't care if its just under the speed of sound it's still going to be pretty loud, vacuum or not.

All that said, I don't share other commenters' pessimism about the engineering feasibility. This guy has a record of making money on far-out ideas and has world-class (universe-class!!) engineering chops. It's still in alpha and it would be easy to pick at details and numbers (it's doesn't all the way across the Bay Bridge! It's only a third of HSR and not a sixth!).

Let's keep an eye on the big picture and think of this as a potentially revolutionary idea that will doubtless change significantly before and as it gets implemented. He doesn't have to get it perfect the first time out.

H.D.

by Hill Dude on Aug 14, 2013 1:23 pm • link • report

Matt, Alon, et al. Are there any elements of the Hyperloop design that are worth salvaging? Would CAHSR or NEC HSR benefit from running in a lower-pressure tube?

by Steve S. on Aug 14, 2013 1:34 pm • link • report

Okay. Sorry. If it carries 28 passengers, a single passenger would about 4% of capacity.

But, we also need to remember that if the solar panels really can generate more power than the system needs than the marginal cost of launching each capsule is less than zero. Aside from wear and tear and taking tickets, it doesn't cost ANYTHING to send a capsule to SF.

How much is it for each HSR train trip?

H.D.

by Hill Dude on Aug 14, 2013 1:37 pm • link • report

All that said, I don't share other commenters' pessimism about the engineering feasibility.

There is a key difference between feasibility and practicality.

The problem with Musk's arugments in favor of the Hyperloop isn't that the concept isn't yet feasible, but rather that he's presenting it as a practical alternative to HSR - with no justification.

For what is basically a mass transit system, any technology must still conform to the basics of transit planning and transit geometry.

Then there's the basic physics of it. If it were feasible to build and operate, that doesn't make it a good option for transport if essentially a 35 minute roller coaster ride. Pass the air sickness bag, please!

For Musk to assert that HSR is bad because of high costs, the idea that some new technology would somehow be immune to cost risk is quite odd, and certainly not practical.

Likewise, in terms of political feasibility, part of CA HSR's problems stem from political influence on the route in order to curry favor; Musk's plan assumes that the genius of his idea will simply roll past such petty political concerns. People may object to large viaducts for HSR, but they'll love large viaducts for a hyperloop? I don't think so. Likewise, NIMBY objections know no bounds - they tend to use whatever leverage they can in opposition.

Yes, it's still in alpha. Yes, it's easy to pick at the numbers. However, the whole selling point of the concept as a transportation system is that those numbers-to-be-nitpicked are better than the alternatives. And, if they're not actually better, then a lot of the justification for the project evaporates instantly. We're left with nothing else but a 'it's cool' justification.

by Alex B. on Aug 14, 2013 1:37 pm • link • report

Re:

"For Musk to assert that HSR is bad because of high costs, the idea that some new technology would somehow be immune to cost risk is quite odd, and certainly not practical."

and

"Likewise, in terms of political feasibility, part of CA HSR's problems stem from political influence on the route in order to curry favor; Musk's plan assumes that the genius of his idea will simply roll past such petty political concerns. People may object to large viaducts for HSR, but they'll love large viaducts for a hyperloop? I don't think so. Likewise, NIMBY objections know no bounds - they tend to use whatever leverage they can in opposition."

I agree...sort of.

Yes, there is cost risk but the upside is so much greater than the HSR that I'm more open to it perhaps than you are.

As for the NIMBY community, I'm totally on board w/ you and think it will be extremely difficult build anything between SF and LA.

I'll also take this opportunity to make the point I love to make about progressive policy goals: there are many many times when environmental protection, historic preservation, living wages for the people that build infrastructure, etc., come into very sharp conflict with --and drive up the costs and delays of-- the progressive goal of HSR.

It will be interesting, entertaining, and informative to watch how those conflicts and trade-offs get settled and solved.

H.D.

by Hill Dude on Aug 14, 2013 1:46 pm • link • report

" Aside from wear and tear and taking tickets, it doesn't cost ANYTHING to send a capsule to SF"

No employees on the pod? What if someone on the pod starts to do something criminal? You're trapped in a small space with them. Hasn't that been an issue with PRT?

Also what if there is an emergency? Isn't that the real reason airplanes have so many flight attendants? The system stops and these two dozen people have to figure out what to do themselves?

by AWalkerInTheCity on Aug 14, 2013 1:46 pm • link • report

@gregincal

> *"They will have a maximum deceleration of 0.5 gs,"*
>
> *That part of your analysis is totally off. That's the normal deceleration when coming into a station. It has nothing to do with how quickly it could brake in an emergency. Coming into a station it uses electromagnetic braking. In an emergency it turns off the airflow and uses normal friction brakes. Stopping in the distance proposed between capsules wouldn't require excessive g forces.*

The issue is not whether the capsule is capable of stopping at more than 0.5 gs. It probably will be able to do so.

The issue is whether the people inside the capsule are capable of stopping at more than 0.5 gs without injury.

Stopping a pod going 760 mph in 30 seconds requires decelerating at 25.333 mph/sec (a force of 1.154 gs).

Stopping a pod going 760 mph in 25 seconds (for a little safety margin) requires decelerating at 30.4 mph/sec (a force of 1.385 gs).

Musk's document claims that accelerations and decelerations will be limited to 0.5 gs (page 38).

And to compare, the maximum braking rate for a Metro car is 3 mph/sec. The hyperloop would be stopping at a rate 10 times higher.

Even if 30 seconds is safe and feasible, it's still less capacity than CAHSR, and in fact, less capacity than 2 freeway lanes. And it doesn't appear that it can scale up without significant cost increases.

by Matt Johnson on Aug 14, 2013 2:02 pm • link • report

So, the best comparison I can think of is the Alaskan Pipeline project. That pipeline cost $8 billion for 800 miles over some very unforgiving terrain. Source: http://en.wikipedia.org/wiki/Construction_of_the_Trans-Alaska_Pipeline_System

If LA to San Franciso is under 400 miles, and you need to construct two tubes that will transport a lot less mass than being full of oil, $6 billion doesn't seem too unreasonable.

by Ryan on Aug 14, 2013 2:08 pm • link • report

Ryan,

Except that the Alaskan Pipeline leaks all the time and doesn't need to be robust enough to transport people safely 99.9% of the time. And was built in the mid-70's (inflation!). And didn't require a brand-new, never used or even proto-typed technology. And they're only ~48 inches in diameter. And don't have nearly the same issue with dynamic loads. Etc....

by David C on Aug 14, 2013 2:14 pm • link • report

@AWalkerInTheCity

It looks like the pod is so small that getting around in it --for either a lunatic or an employee-- would be very difficult. For emergencies, presumably each seat would have some kind of emergency alert button.

Even conceding your point, the marginal cost per journey would be...say...$15? Not much, even when amortizing over just one passenger in the whole capsule.

The point more generally is to compare the cost required to send a capsule along the length of the Hyperloop and to send a train along the length of the CAHSR.

The cost for the Hyperloop would be negligible while the cost for the CAHSR...would not. Yes, California is trying to source its energy from renewable sources but that does not address the question of cost.

H.D.

by Hill Dude on Aug 14, 2013 2:17 pm • link • report

That's the normal deceleration when coming into a station. It has nothing to do with how quickly it could brake in an emergency. Coming into a station it uses electromagnetic braking. In an emergency it turns off the airflow and uses normal friction brakes.

The document prepared by the Hyerloop team states that 0.5g is the maximum deceleration "that can be comfortably sustained by humans for short periods".

Though humans could sustain much higher g-forces than 0.5g (some rollercoasters provide up to 6.5g for a short duration), the Hyperloop documents do not state precisely what the emergency deceleration would be.

One thing for sure is that "normal friction brakes" would not work because no such brakes exist for this type of technology.

Also, it is worth noting that the Hyperloop is designed to travel up to 700 mph during "coasting" and 300 mph when traveling through urban areas, mountains, curves, etc. So 28 minutes trip duration is quite generous.

Also, the documents state that the Hyperloop would average 2-minute headways for a total of 840 passengers per hour, which is far fewer than its theoretical maximum capacity of 3,300 passengers per hour.

by Scoot on Aug 14, 2013 2:20 pm • link • report

In 2013, the cost of the Alaska Pipeline would be $32 billion.

H.D.

by Hill Dude on Aug 14, 2013 2:20 pm • link • report

The Trans-Alaska Pipeline is a fraction of the size, not built to laser straightness, on very short and simple pylons, doesn't contain fancy hover-cars, and isn't covered in solar collectors. The similarities begin and end with "they are long tubes."

Also, it was $8 billion in 1976 money. That's $33 billion now. In a state that didn't really have to worry about who owned the land. Keystone XL was going to cost $13 billion. You couldn't build the Trans Alaskan Pipeline for $8 billion now. What makes you think you could build something even bigger and more ambitious for less?

by Another Nick on Aug 14, 2013 2:22 pm • link • report

And just as a point of comparison on horizontal g-forces; compared to an airliner at takeoff:

For a B777-300 with 2 GE90-115, total thrust (flat out) is 230000lbs or 1023000N. MTOW basic for the B777 is 580000lbs, or 263000kg. Acceleration is 1023000/263000 = 3.89m/s2 = 3.89/9.81g = 0.3965g (horizontally).

So, slamming on the brakes for an emergency hyperloop stop, and exerting 1.4 Gs (horizontally) would be a very big jolt.

by Alex B. on Aug 14, 2013 2:25 pm • link • report

" For emergencies, presumably each seat would have some kind of emergency alert button."

thats nice. I'm in the middle of the line, the pod stops. For some reason, heaven knows what. I am in a little pod, with no bathroom or water, in the middle of a dark tube. I press the button. What happens? How does that help me?

by AWalkerInTheCity on Aug 14, 2013 2:25 pm • link • report

Musk's "estimates" are unrealistic, but too close a comparison between these small vehicles and full-size trains can be misleading. By keeping the actual vehicles small, construction can be easier. For example any elevated parts are much easier and cheaper - you don't need gigantic concrete structures like freeway overpasses.

Of course the smaller vehicles mean lower total payloads at realistic rates - which Musk's are not.

by skeptonomist on Aug 14, 2013 2:31 pm • link • report

@Walkerinthecity.

I have no idea.

But I'm not addressing emergency procedures; I'm addressing marginal cost.

I'm sure there is a solution and, if there's not one that you feel comfortable with, consider driving.

H.D.

by Hill Dude on Aug 14, 2013 2:32 pm • link • report

I am in a little pod, with no bathroom or water, in the middle of a dark tube. I press the button. What happens? How does that help me?

Well, the Hyperloop team um, optimistically (?) suggest that in the case of an emergency, all the capsules would just continue to their destination because they're all going 700 MPH to begin with. Or something like that.

by Scoot on Aug 14, 2013 2:36 pm • link • report

"But I'm not addressing emergency procedures; I'm addressing marginal cost."

I would think you need at least one well trained employee per pod. Which both adds an incremental cost per pod, and reduces capacity by 1/28th.

"I'm sure there is a solution and, if there's not one that you feel comfortable with, consider driving."

The issue at hand is not what mode I should choose for trips between LA and SF, but whether constructing CAHSR should be delayed because of this. Given the MANY issues that have been raised with this (of which mine is a minor one) I don't think delay of CAHSR is warranted.

If this is such a good idea, why is Musk only touting it for LA-SF? Why not LA-Las Vegas, where HSR is more questionable, less imminent, and where volumes might better match the hyperloop capacity? There are other corridors to explore, and as others have said, other applications for this technology.

It does sound less like a serious proposal, and more like a way to stop CAHSR.

by AWalkerInTheCity on Aug 14, 2013 2:37 pm • link • report

@Alon Levy
Richard B: the proposal calls for 0.8-1" thick tube, with an internal diameter of 7.3-11'. Despite all the hype you could read at some places (like the pro-Hyperloop comments on my blog), it's actually fairly heavy and, in addition to the cost of raw materials, the cost of putting up the viaduct structures to support the tube would be comparable to the cost of HSR viaducts. That's 10 times as high as the cost claimed in the proposal.
so that makes my calc come out to $1.2 billion just for the steel for the tube. Clearly he is missing a few things from his economic analysis.

by Richard B on Aug 14, 2013 2:37 pm • link • report

"On Monday, entrepreneur Elon Musk announced plans to build a super-fast tube train connecting Los Angeles and San Francisco."

Your very first sentence is factually incorrect. Musk certainly did not announce plans to build anything. He released a concept, a proposal. He clearly said that he'd like to see someone pick up on the idea and advance it.

by Kevin on Aug 14, 2013 2:39 pm • link • report

"Well, the Hyperloop team um, optimistically (?) suggest that in the case of an emergency, all the capsules would just continue to their destination because they're all going 700 MPH to begin with. Or something like that."

well if the emergeny is that I have a coronary lets say, thats probably fine (I mean on an airplane I really don't think theres much the flight attendants could do for me - better to get to a place where an ambulance can get to me fast)

Im suggesting what if there is a problem with the system? The assumption seems to be that there will be no problems with the system.

by AWalkerInTheCity on Aug 14, 2013 2:40 pm • link • report

Nice work, Alon Levy and Richard B. My only thought is that I'm not sure if the tube is going to be steel. Could it possibly be concrete?

I guess it could be, but concrete needs reinforcing steel and it will need a liner to hold the pressure. If it were made of reinforced concrete 1" wouldnt be enough to resist the pressure or have the tube stand it's own weight.(much less the vibration caused by vehicles going through it at 750mph)

by Richard B on Aug 14, 2013 2:45 pm • link • report

"The train in question would be both
slower, more expensive to operate (if unsubsidized) and less safe by two orders
of magnitude than flying, so why would anyone use it?"

this sentence is misleading. There are of course ridership studies showing it would be used. It would be subsidized, because the alternative is very expensive (if even possible) expansions to airport capacity. As the EIS discussed IIRC.

If this idea is so great, why does it need to be accompanied by unfair attacks on CAHSR?

by AWalkerInTheCity on Aug 14, 2013 2:48 pm • link • report

I agree with Kevin. It is just a concept. The proposal raises more questions than answers -- which is a good thing -- but the proposal as it is written is intended to be more like a conceptual thesis than a plan to actual build something.

by Scoot on Aug 14, 2013 2:52 pm • link • report

The Trans-Alaska Pipeline is a fraction of the size, not built to laser straightness, on very short and simple pylons, doesn't contain fancy hover-cars, and isn't covered in solar collectors. The similarities begin and end with "they are long tubes."
Also, it was $8 billion in 1976 money. That's $33 billion now. In a state that didn't really have to worry about who owned the land. Keystone XL was going to cost $13 billion. You couldn't build the Trans Alaskan Pipeline for $8 billion now. What makes you think you could build something even bigger and more ambitious for less?

So the transAlaskan is 2' wide. This would be 10' or so. Just one size that would make it 25 times more expensive to make the tube. (half for being only 400 miles but then doubled for one tube each way)
750 billion...

by Richard B on Aug 14, 2013 2:53 pm • link • report

Here's an interesting piece on Musk and his space and Tesla ventures. Be sure to read both pages: the first is the attack, the second the rebuttal.

http://pjmedia.com/blog/hyperloop-tesla-spacex-and-the-usual-elon-musk-bashing-nonsense/

H.D.

by Hill Dude on Aug 14, 2013 3:06 pm • link • report

HD

thats all personal stuff back and forth, and has nothing to do with the issues we've been discussing. Plus its PJmedia a right wing blog (a big cheer leader for Dick Cheney back in 2003, IIRC) Naturally they are more interested in debating if Musk relies on govt contracts for SpaceX. I dont really care that he did or didnt - just that his experience with SpaceX (which AFAICT was simply commercialization of an established technology) does not support "arguements from authority" for believing him on hyperloops, or on HSR in general.

by AWalkerInTheCity on Aug 14, 2013 3:17 pm • link • report

I mean a lot of this seems to boil down to what that expert on transportation technology, tevye the milkman, once said

"when you're rich, they think you really know!"

by AWalkerInTheCity on Aug 14, 2013 3:19 pm • link • report

Every new technology has its share of doubters and detractors, and the same thing is happening here.

If the Hyperloop can be proven, and Elon Musk has said he may have to build a demonstration prototype himself, then this is the type of breakthrough that transportation advocates should support.

When Musk was building SpaceX, he was ridiculed and doubted by the established space industry. Now he is successfully delivering payloads to ISS at a fraction of the cost.

Sure, you could look at his current projects, and say this is self-promotion. But then, you could also look at the companies he's built and recognize that these are incredible accomplishments. I mean, he's going to space!

I wouldn't bet against Elon Musk.

by LI on Aug 14, 2013 3:22 pm • link • report

@AWITC - Flight attendants are trained in first aid and are equipped with numerous pieces of equipment to come to the aid of passengers (included defibrillators).

On separate note, what about terrorism? What type of precaution would be taken from someone blowing the tubes off their perches? What happens if they are breached, either accidentally or purposely? Musk said that the land below could still be used for other purposes (road, farming, etc), but would it when security issues are highlighted? And, then you land procurement costs are going to sky-rocket!

by Thad on Aug 14, 2013 3:26 pm • link • report

Every new technology has its share of doubters and detractors, and the same thing is happening here.

But this is neither 'new,' nor is it 'technology.' This is a concept; and the concept of some sort of evacuated tube transport system is not a new one. Likewise, the concept relies on technologies that seem plausible, but they do not exist yet anywhere but in this white paper.

If the Hyperloop can be proven, and Elon Musk has said he may have to build a demonstration prototype himself, then this is the type of breakthrough that transportation advocates should support.

Sure, but let's not dance around that 'if.' That is one very big if.

Now, contrast that against high speed rail; Musk's apparent foil here. HSR is a proven technology, and therefore it is a technology that advocates support.

I wouldn't bet against Elon Musk.

Doesn't mean you have to bet for him, either.

And, as he has noted, Elon Musk won't be the one building this thing (if anyone does). So, it would seem that this particular idea is without a leader.

by Alex B. on Aug 14, 2013 3:33 pm • link • report

"If the Hyperloop can be proven, and Elon Musk has said he may have to build a demonstration prototype himself, then this is the type of breakthrough that transportation advocates should support."

I don't think anyone is against further research on the technology.

I think some people are more concerned with delaying HSR proposals currently in the pipeline based on it.

by AWalkerInTheCity on Aug 14, 2013 3:34 pm • link • report

When Musk was building SpaceX, he was ridiculed and doubted by the established space industry.

Questioned? Yes. Doubted? maybe. Ridiculed? No.

Now he is successfully delivering payloads to ISS at a fraction of the cost.

True. As long as that fraction is 1/1. It costs about the same to launch on Falcon 9 as it does on Arianne. And no one is sure that he's making money on it. It's easy to bring costs down as long as you're willing to lose money.

But then, you could also look at the companies he's built and recognize that these are incredible accomplishments. I mean, he's going to space!

So is North Korea.

I love Elon Musk. I think he's amazing - crazy smart in both science and business. I'm glad he's doing the things that he's doing. But there was no need for him to bash CAHSR as part of this white paper release. And with such a half-baked idea he came off looking bad. He should at least have a working proto-type. He could have just said "Here's my idea. I don't know if it will work, but I think it could. Maybe someone will run with it." But he didn't handle it that way and he opened himself up to criticism.

Same with his criticism of NASA. It's unnecessary and it might cost him the Crew Vehicle contract (the proposals for the next phase are due tomorrow, btw. Coincidence?) I read about the guy all I can, and I can't tell if this is self-promotion, brand-promotion, just arrogance or all three. If he keeps this kind of stuff up he runs the risk of looking like another incredibly smart billionaire - Donald Trump.

by David C on Aug 14, 2013 3:37 pm • link • report

@walkerinthecity,

Please get your facts straight. PJMedia is not a blog but an Internet media company and blog aggregator / publisher. And so what if they supported Dick Cheney?

I didn't post it because I thought it was relevant to the economics but because I thought it was interesting background on Musk and his companies and an interesting take down of an attack against him.

H.D.

by Hill Dude on Aug 14, 2013 3:37 pm • link • report

Plus its PJmedia a right wing blog

An unnecessary cheap shot in response to the link HD posted. And also inaccurate: the writer, Rand Simberg, is libertarian, as are many of the other bloggers and writers at that site.

by Bitter Brew on Aug 14, 2013 3:41 pm • link • report

Hill dude

PJ started as a blog or aggregation of bloggers, I think - hence the "PJ" from a derogatory reference to bloggers in their pajamas. given the way the world is, Im not surprised they are now a "media company". And IIRC they were part of the chorus that was not only wrong about international events in the early 2000s, but was vicious about it. I would wait to see if they have admitted that before taking anything they say very seriously. Of course if they had persusive analysis, that would be worthy whatever the source - but all this is a take down of something no one has even been mentioned here. Im not sure why its relevant.

by AWalkerInTheCity on Aug 14, 2013 3:44 pm • link • report

I don't understand the passenger per hour comparisons given how different the travel times are. If both options took three hours but the hyperloop held one tenth the capacity then you could compare the costs. But the point is to get people places not simply put them into the system. By your logic all these options pale in comparison to dispatching retrofitted container ships up the coast every hour.

A related point is that having the capacity debate ignorant of demand is not particularly enlightening. Who cares what the passenger per hour capacity is if the trains are sitting empty.

Finally, and this minor, it's not likely he project costs would scale at 1:1, there would be some economies of scale it's just unclear what they would be.

by Erik on Aug 14, 2013 3:44 pm • link • report

Many of us aren't shooting down the idea, just his cost estimate.

This is a maglev train, one that is smaller than most and operates inside a tube. The tube is then evacuated of air so there is less drag.

Now there are working maglev trains in the world. I have ridden on some. They aren't exactly cheap and I am not sure that air resistance is the reason.

In shanghai there is a maglev train that runs from the airport into the suburbs. It is $9 and operates at a loss. It was not extended into the core of the city because of NIMBY(yup NIMBY in china, hard to fathom). If building a tube around it and sucking out all the air would somehow make it cheaper and faster they probably would have done so.

by Richard B on Aug 14, 2013 3:45 pm • link • report

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bitter brew

And libertarians are not right wingers? Wasnt PJ part of the group of libertarians (including what was it called,instamedia?) that became big league cheerleaders for everything that Rumsfeld/Cheney said or did and that use named calling (and abundant cheap shots) at anyone who disagreed?

by AWalkerInTheCity on Aug 14, 2013 3:46 pm • link • report

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since discussions of musks character from ideological sources are okay, heres something to chew on

http://www.motherjones.com/mojo/2012/07/ayn-rand-elon-musk-spacex

Its NOT about Musk, but gives some clues as to why some folks are so enamored of him.

by AWalkerInTheCity on Aug 14, 2013 3:57 pm • link • report

@Erik,

The thing that I find interesting is the combination of speed, the relatively small numbers of people being transported per "launch", the possible frequency of launches, and the low marginal cost of each launch (that is, the additional cost of one more launch is very very low).

That allows for a lot of responsiveness to demand and means that the system is not spending a lot of money on sending just a few passengers on a huge train on a long and high-energy consumption train ride. It can also function sort of like a shuttle: it goes either when it fills up or, say, every ten minutes even if it is not full.

I wonder if daily passenger load on current flights between LAX (and Burbank) and SFO would be a good proxy for demand. Can we assume that almost all of those people would want to take the Hyperloop? Can we further assume the great speed of such a system would increase demand some?

I'm not going to sit down and do the math but it would be interesting to think about those numbers in terms of possible revenue and daily capacity.

This is all, of course, very theoretical and hardly enough to be a proof of economic / engineering viability but it does give a sense of its ability to be a game changer.

H.D.

by Hill Dude on Aug 14, 2013 4:00 pm • link • report

@Hill Dude:

CAHSR anticipates the demand for trips along the LA-SF spine at 27M annual trips in 2030. Of course, that includes people going to Bakersfield and Fresno and San Jose.

Musk's proposal claims the ability to move 14M annual trips.

Of course, that also presumes that demand is somewhat even.

If the Hyperloop can carry 3360 passengers per hour and people show up evenly thoughout the day, that's fine. But let's keep in mind that Musk envisions this as a commuter mode, not an intercity mode.

So if 8000 people show up at Bayfair Terminal between 7:00A and 8:00A on their way to their cushy jobs in the Sylmar financial district, we've got a problem.

It's not like Hyperloop can take empty seats from the 12:00 hour and put them up in the morning. If more than 3360 people show up in an hour, they'll start queuing.

And at $20 a ticket (probably cheaper than Greyhound), people will definitely come.

Incidentally, CAHSR uses a load factor of 70% for their trains, based on the load factor seen on other high-speed lines.

by Matt Johnson on Aug 14, 2013 4:09 pm • link • report

According to one site (http://www.america2050.org/high-speed-rail.html) 27 million is the high end of their estimation and 16 million is the low end.

At the low end the loop is pretty close to the projected high speed ridership though, to be sure, rail would be able to make more stops and therefore have a higher number of total riders even though the average trip distance would probably be lower.

H.D.

by Hill Dude on Aug 14, 2013 4:24 pm • link • report

My point in bringing up the Alaskan Pipeline is that it was an engineering marvel that was built almost 40 years ago that involved a lot of new innovations to tackle unique challenges. That and the Concord supersonic passenger jet were both products of the 1970s. Are we not living in the future? Maybe the Hyperloop isn't yet ready for prime time, but the open and crowd-sourced nature of the project is very exciting. Maybe it will end up costing $30 billion and only go 400 MPH, that still represents a huge gain over the High Speed Rail proposal. Maybe Hyperloop is better compared to something like MAGLEV?

by Ryan on Aug 14, 2013 4:27 pm • link • report

So if people here are offended because Elon Musk bashed HSR in his Hyperloop proposal, that's totally understandable. You might even think he's an arrogant prick, although it does take a certain arrogance to go to space.

However, I don't know if the best response is to turn around and bash the Hyperloop. Elon Musk is quoted as saying that he will "probably" build a demo (link below)...

Wouldn't it be more FUN to think about where he should build a Hyperloop prototype?!?

He basically needs a good stretch that's long and straight, and avoids any eminent domain issues. The longer the better from a demo perspective, but not from a cost perspective. If I were a state, I would consider working with him on this.

This could be a fun thought exercise... :)

“I think it might help if I built a demonstration article. I think I probably will do that, actually. I’ve sort of come around in my thinking on that part.” - Elon Musk on Hyperloop

http://www.forbes.com/sites/hannahelliott/2013/08/12/latest-update-elon-musk-will-start-the-hyperloop-himself/

by LI on Aug 14, 2013 4:30 pm • link • report

"Maybe it will end up costing $30 billion and only go 400 MPH, that still represents a huge gain over the High Speed Rail proposal. "

maybe it will cost almost as much as HSR, and have one tenth the capacity? In which case its not a superior alternative.

by AWalkerInTheCity on Aug 14, 2013 4:37 pm • link • report

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maybe it will cost almost as much as HSR, and have one tenth the capacity? In which case its not a superior alternative.

Also note that the CA HSR cost estimate in 2013 dollars is $53b. That jumps to $68b due to inflation when you do the project in year-of-expenditure dollars.

So, if Hyperloop experiences a 5x cost overrun (not exactly unheard of for a completely unproven technology, yet alone a large infrastructure project), you're at that $30b number - for which the appropriate comparison cost for HSR is $53b, for a system with much greater capacity and better options for last-mile travel.

by Alex B. on Aug 14, 2013 4:49 pm • link • report

The end problem is the bulk of costs in almost any proposal are going to come down to land issues. One of the reasons France could do high speed pretty easy is that they have decidely denser urban developments and lots of countryside. America on the otherhand has 10s or 100s of miles of sprawl around cities. No proposal is going to circumvent that short of tunneling which is partly why the 200 mile Maglev in Japan is going to be like $100+ billion. Funny how no one (outside of certain circles) bats at eye when we spend that kind of money on highways.

by Alan B. on Aug 14, 2013 5:07 pm • link • report

Wouldn't it be more FUN to think about where he should build a Hyperloop prototype?!?

Yes, definitely, although it begs the question "how big a prototype is necessary?" If it's something on the order of a couple of miles, let's build the prototype right here in the DC area -- somewhere that needs a transit link that's far off otherwise -- and then we can use it after the experimentation is done. Maybe between VA and MD where they had discussed the "Techway"? Since the Hyperloop isn't useful for intermediate stops, there'd be no concern about sprawl, but it would be a super-valuable link between say, the Silver Line in VA and the Red Line in MD, and long before we'll ever see a Purple Line or WMATA connection on that route.

If the prototype needs to be a hundred miles, I nominate Cocklebiddy, Australia, on the long straightaway of the Eyre Highway. Who wouldn't want an excuse to go visit?

@AWITC:
And libertarians are not right wingers?

No, and if you think otherwise, I encourage you to learn more about libertarian views on subjects like government surveillance, marriage equality, the drug war, criminal sentencing, etc.

As for the Pjmedia collection of writers and their views on foreign policy, my observation is that they range widely. Some of the writers there were among the lonely opponents to the Patriot Act when it was first passed -- although I think in separate writings because that predated the existence of the organization.

by Bitter Brew on Aug 14, 2013 5:26 pm • link • report

Nice criticism, but I wish the author would extend his same skepticism of Hyperloop to CAHSR's ridership estimates, speed cost, build schedule, and even it's path (the current CAHSR plans don't actually call for HS travel from dtown LA to dtown SF for *decades*, probably never, owing to $$$ and shared tracks with existing freight and intracity rail).

by Alex M on Aug 14, 2013 5:27 pm • link • report

Comparing a Maglev, the Shanghai maglev cost $1.3 billion for 18 miles. That extrapolates out to 28 billion for SF to LA.

This was in 2001 and in China when and where construction costs are much lower.

by Richard B on Aug 14, 2013 5:30 pm • link • report

So, if Hyperloop experiences a 5x cost overrun (not exactly unheard of for a completely unproven technology, yet alone a large infrastructure project), you're at that $30b number - for which the appropriate comparison cost for HSR is $53b.

Assuming, of course, that HSR does not itself experience cost overruns...

by Bitter Brew on Aug 14, 2013 5:30 pm • link • report

The Hyperloop proposal explicitly says the tube will be made of steel of width 20-23 mm in the 2.23 m diameter version and 23-25 mm in the 3.3 m diameter version. Compare this with the Alaska pipeline: 1/2" (i.e. 13 mm) pipeline width, 4' diameter (i.e. 1.22 m). The larger-diameter version of Hyperloop requires five times as much material.

Gregincal, re the deceleration rate, a 0.5 g rate in normal service is going to give passengers motion sickness. My other comment about emergency braking is that the established parameters about top speed and minimum headway require an average braking rate of at least 0.58 g, which is even worse than what passengers take on airplanes on a regular basis.

And everyone who thinks in terms of cost overruns on Musk's proposal: you're doing it wrong. Musk made up a number. You're letting him anchor your expectations. The correct way to estimate costs is to look at costs of similar pieces of infrastructure, which are an order of magnitude higher assuming the technical parts of maintaining high-precision tubes are easy.

by Alon Levy on Aug 14, 2013 5:37 pm • link • report

"No, and if you think otherwise, I encourage you to learn more about libertarian views on subjects like government surveillance, marriage equality, the drug war, criminal sentencing, etc."

call me a marxist if you will, but I think economic and class issues are the core of "left" and "right" and that most of the other issues are orthogonal. Way back in 1848 "classical liberals" faced with the reality of the political split in the streets, chose to align with the illiberal right. The "libertarian" bloggers PJ and Reynolds are associated with did the same in 2004, and AFAICT have stuck to that position.

Thats a matter of political reality, not intellectual theory.

by AWalkerInTheCity on Aug 14, 2013 5:40 pm • link • report

Wouldn't it be more FUN to think about where he should build a Hyperloop prototype?!?

DC to Baltimore, downtown to downtown is an often considered route to prove technology. The route is well traveled, relatively flat and not too many people want to get off in the middle.

It had the first telegraph
It had the first passenger rail between two cities(depends on what you consider a city but still)
It was in the running for the US's first maglev, but dropped out when the technology proved too expensive.

It would be good for a proof of concept line of 40 miles before going to 400.

by Richard B on Aug 14, 2013 5:45 pm • link • report

"HSR does not itself experience cost overruns..."

But HSR has been built on this planet. So we have an idea of how to estimate costs.

When the Wright Brothers designed the airplane, they did NOT try to estimate costs for a full aviation system, or suggest that railroads were a bad idea. They tinkered, demonstrated, and their ideas were implemented over generations.

Tesla is an electic car. the roots go pretty far back, and work on modern electric cars has been done for decades now. SpaceX applied rocketry.

Hyperloop is unproven, in many ways, untested for feasibility, cost, etc. And its already being touted as making HSR unnecessary. That seems foolish to me.

by AWalkerInTheCity on Aug 14, 2013 5:45 pm • link • report

But, you are all pretending that the Slow Bullet to Nowhere will actually be completed and be used by 12,000 people per hour. If the Hyperloop fails, it will only be $6B wasted. But the Slow Bullet, which is even more certain to fail, will not be acknowledged as a failure until the whole $70B has been wasted. We can save over $60B by failing cheaply. That's $1500 for every man, woman, and child in California, which could be reallocated for the educational and health systems of California, by choosing the cheaper way to fail.

by Marcs on Aug 14, 2013 5:59 pm • link • report

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hyperloop is an improved maglev. Maglev has not yet been demonstrated to be a cost effective technology. Adding the price of the tube, which we have shown to be rather high, and the vacuum, which will also be expensive you still might not make Maglev feasible, as high aerodynamic drag is not maglevs limiting feature.

by Richard B on Aug 14, 2013 5:59 pm • link • report

Marcs,

That's if someone actually builds what is proposed at $6B and it moves what it's proposed to move.

Meanwhile trains are a pretty proven technology with plenty of successes to look at and adopt best practices.

by Canaan on Aug 14, 2013 6:30 pm • link • report

I think that the basic thrust of your argument is right, but you shouldn't have used the Cypress Structure collapse as evidence. It didn't fail because it was elevated; elevated structures can be seismically safe. Also, it was more than 40 miles from the epicenter; it is near the Hayward Fault, but it was the San Andreas (more specifically, a segment of the fault that is in the Santa Cruz mountains, centered at Loma Prieta) that slipped. The Cypress structure failed because it was misdesigned, and the good news about that is that the old Embarcadero Freeway on the east side of SF, which was similarly misdesigned, was torn down, making the eastern shoreline of the city much more beautiful.

If the only issue were that it needs to be at grade when crossing earthquake faults, the design could be modified. But the other points you raise (much less capacity, only serving SF and La when more people live in San Jose, emergency braking) are more than sufficient to kill it (to the extent that it is a serious proposal).

by Joe Buck on Aug 14, 2013 8:06 pm • link • report

I like trains. I want to see the California High-Speed Rail be an actual travel option. SF to LA high speed rail been talked about all my life. But it's still just talk, studies, etc. Merced-Fresno doesn't cut it.

by Rusty H on Aug 14, 2013 8:24 pm • link • report

Or, Marcs, we can make the assumption that CAHSR would be used because Amtrak's third, fourth, and sixth busiest routes in the country are the three California corridors.

by Another Nick on Aug 14, 2013 8:52 pm • link • report

CA HSR has a few fatal flaws in the model: there is no decent regional transit at either end, nor in Bakerfield, Fresno etc. Who will take a train that isn't especially fast, to a single station nowhere near most of the real destinations, and still have to rent a car on arrival?

The passenger miles traveled is far higher "locally" than long distance.

For the $100B Governor Moonbeam proposes to spend for a train that won't work as transportation, we could to a real investment in regional transit in the Bay Area or the Southland.

Kill highspeed rail sooner, not later, please.

by Gary47290 on Aug 15, 2013 1:30 am • link • report

You are attacking on alpha design, it is not meant to be yet complete. All your criticism is very easy to fix.

There are no inherent reasons why capacity per pod is limited to 28 persons, and Musk proposed also larger and more expensive 10 billion version that can carry three cars or lot more people.

Also midway stations are easy to incorporate and they were proposed. Also paraller tubes are possible.

There was pointed out that emergency braking can have lot more decelartion than half g. So this criticism of yours was based on your ideological assurance. It seems that in general that you did not even bothered to read the 57 page article, before writing your rant.

The weak points are not what you did point out, but they are technical. It may well be that Hyperloop is not technologically feasible.

Safety issues are also very dangerous at near vacuum tube.

by Jouni Valkonen on Aug 15, 2013 8:06 am • link • report

The most important weakness in your cricism is that there are no demand for 12 000 people per hour between LA and SF even during peak hours, but proposed hyperloop has enough capacity to fill the demand. This is why CA HSR is too expensive because it cannot be utilized at full capacity even during peak hours.

by Jouni Valkonen on Aug 15, 2013 8:20 am • link • report

The most important weakness in your cricism is that there are no demand for 12 000 people per hour between LA and SF even during peak hours, but proposed hyperloop has enough capacity to fill the demand.

Maybe there isn't enough demand for that capacity between LA and SF. That's why the train also stops in places in-between!

Not to mention the fact that SOMEDAY there may be enough demand for all of that capacity. And the HSR will be able to meet it. Hyperloop won't.

You are attacking on alpha design, it is not meant to be yet complete. All your criticism is very easy to fix.

Some may be easy to fix. Certainly fixing them will result in a massive increase in price.

Looks to me like this seems like a great idea only to the people who are willing to handwave away the obvious glaring problems with it. This is like having to deal with PRT kooks.

by MLD on Aug 15, 2013 8:36 am • link • report

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there is no decent regional transit at either end, nor in Bakerfield, Fresno etc.

There's no good regional transit in San Francisco or LA? That is news to me. And to the millions of area transit users.

For the $100B Governor Moonbeam proposes to spend

To be fair, this started under the previous, Republican administration. Making it bi-partisan.

And please, oh please, do not refer to the LA area as "the Southland." It's seriously the dumbest nickname for LA I've ever heard. If you don't eat grits once a week and if you never reckon you're fixin' to do something, then you're not "the Southland" (see: Southland Conference).

by David C on Aug 15, 2013 9:14 am • link • report

HA HA!! So many smart ass people doing the maths!! Technically a battery powered car was also not suppose to work against the big giants like GM/FORD... but look at it!! GM/FORD are begging people to buy their crap and Tesla has a waiting list with the average car price of around 70K!!
Makes sense? Only time and a prototype will tell how sensible this idea is.... So save your morning energy and do something meaningful guys!!

by AK on Aug 15, 2013 9:41 am • link • report

"Only time and a prototype will tell how sensible this idea "

agreed. So it shouldn't impact decisions on infrastructure already moving forward.

by AWalkerInTheCity on Aug 15, 2013 9:51 am • link • report

Agreed, this is starting to sound like some people who are convinced we don't need to plan for density downtown and metro expansions to handle because soon we'll all be in self driving cars and they'll be able to move more people more efficiently than any train and we'll eliminate traffic jams in the process.

by drumz on Aug 15, 2013 10:01 am • link • report

Technically a battery powered car was also not suppose to work against the big giants like GM/FORD.

Technically both GM and Ford sell way more cars then Tesla and make way more profit.

Tesla is cool. SpaceX is cool. And both have succeeded in marketplaces that are littered with the remnants of dead predecessors. Both have done better than all of those others. Musk and his colleagues should be complimented for that.

But...neither company has crossed the finish line and they have a long way to go till they get there. If they fizzle out now, neither will be viewed as a true success and they have a long way to go and many obstacles to overcome to get there. I understand the enthusiasm, but the idea that Tesla is beating GM and Ford (or even taking sales away from them) is a over the top. They may get there, but it may be that the big car makers pivot and crush them (thanks in part to some perhaps unfair advantages) before they become much more than DeLorean (they had a waiting list too).

by David C on Aug 15, 2013 10:40 am • link • report

I have a number of issues with this, but first I need to see whether I can *actually* post... just a sec.

by Nafnlaus on Aug 15, 2013 11:27 am • link • report

Okay, here we go.

"After all, the guy proposing this revolution in transit owns a car company. "

He also owns a rocket company. Maybe it's a plan to derail the rocket industry! He also owns a solar company. Maybe it's a plan to derail the solar industry!

Or maybe, just maybe, an ubergeek physics major on several national engineering boards who pumped tons of his own money into forming several other similar advanced engineering-related topics *actually* has an interest in such a thing?

"But the Hyperloop doesn't actually make it to downtown LA or downtown San Francisco."

Like an airport. Remember, he said this is something sort of in-between rail travel and air travel.

If one wants to extend it into downtown, it's not hard to see how - overlying rail, which should be easy and cheap to get right of way for. In LA, follow the almost perfectly straight rail line from Sylmar to the northeast corner of Griffith Park, or if you accept some small curves, the railyard near the northeast corner of Elysian Park. In SF, you have to take one relevant curve to the northwest just west of E. 14th to get over the rail line, but from there, the rest of the curves are fairly small, and you let out at the rail yard just a couple miles from the Bay Bridge. In all cases, the station could be built on low-density industrial land, aka, not super-expensive.

"It also has a maximum passenger capacity of just 10% of the HSR line."

No, it has a capacity about 25% of HSR. 10% is your made-up number.

"And it bypasses all of the intermediate population centers in central California that HSR will serve."

In the base version. There's also an extended version which also goes to Anaheim, Sacramento, San Diego, and Vegas.

"If it sounds too good to be true, you should probably double-check the math."

Or it actually *could* be a real solution. Like Musk's other projects.

"At that rate of braking, it will take a pod 68.4 seconds to come to a full stop. That's a pretty significant issue because safe vehicle operation means never getting closer to the vehicle ahead than the distance it will take you to stop."

That's a rule for *human controlled* systems. Automated carpool trains can drive literally milliseconds apart from each other. This 30 seconds is IMHO a huge margin of error, likely driven more by airflow issues than safety ones.

"If pod A were to experience a catastrophic air-skid failure, crash into the tube wall, and disintegrate, pod B, 30 seconds back, would not be able to stop short of the wreckage."

Yeah, in a magical world where inertia ceases to exist. Sorry, but if the car in front disentigrates, *it's still going many hundreds of miles per hour*.

"With a capacity of 1,260 passengers per tube, that means that the Hyperloop would need 10 tubes in each direction"

Ignoring your fictional numbers where you reduce the tubes' capacity, again I must remind you that Musk states it's like a cross between rail and air travel. It has about a quarter the capacity of HSR, but about three times the capacity of the LA-SF air link.

"And that would push the cost up by 10"

In the magical world where everything is linear and we use your fake figures. You do realize that the biggest part of the cost for such projects (both HSR and hyperloop) is land acquisition, right? The pair of tubes is only $650M. Which IMHO sounds like an overestimate to me, the amount of steel being talked about should cost about $120M at $400/tonne (cheap steel), and even if you double that for precision manufacture and high quality steel, that's still a third of Musk's figure.

"The Hyperloop will have chokepoints, too. Because the tubes will be kept at a near-vacuum, each station will have an airlock that trains pass through. Every time a pod arrives, it has to decelerate and stop. Then the airlock will have to close, pressurize, and open again. Then the pod has to clear the airlock. Then the airlock can close, depressurize, and then reopen. "

And this is why you will never be an Elon Musk - you have not a whit of "engineer" to you. An engineer can look at that and figure out the obvious solution before they even finish your sentence: "you don't load all the capsules in a single airlock". You have a bunch of airlocks sitting in parallel, people get into a particular one, the airlock closes, it's depressurized, the route to the main tunnel is opened, and *then* it goes and merges into the main tunnel.

Stop and think about these things before you complain.

"Meanwhile, Musk says that each station can have 3 pods on the platform at once. If pods arrive every 30 seconds, then passengers and baggage have to get off within 60 seconds."

My experience was about 1 1/2 minutes per stop on high speed commuter rail in Japan. And worst case scenario? You just have more pods per station - oh noes! The pods are cheap.

"One arthritic passenger or a guy who goes back for the iPhone he left behind"

What sort of high speed rail station delays a whole train for a guy who leaves their iPod? If they have good customer service, they send it back on the next return trip. If they don't, it stays in their lost & found on the other end and it's your responsibility to get it (costing you $20 each way and a lost hour). The former is how HSR is managed in Japan for lost items.

"But bridges are far more expensive than building tracks at grade."

Except that hyperloop columns bear far less load than rail bridge columns of the same spacing, due to the much lighter track and "trains".

"And just because the footprint is limited to a big pylon every 100 feet doesn't mean that the environmental impact analysis process will be any easier or that the public will be any more receptive. "

Except that the whole point is that the footprint is so small that the vast majority of it can be built *in the median of I-5*, unlike a train. There should be pretty much zero difficulty passing an environmental impact study for building in the median of an already existing highway. It's already an unnatural environment and all you're doing is plopping a column every hundred feet. Right-of-way should be similarly trivial - it's public land.

"Other issues, like seismic stability, are simply glossed over."

They distinctly are not. I mean, if you're expecting a 100-page investigation, well, sorry, the whole report isn't that long, but it's clearly not an afterthought.

"He claims that by elevating the Hyperloop tracks, they will be more stable than ground-running HSR. Clearly he's unfamiliar with the Cypress Street Viaduct."

Sorry, but one case of an elevated structure failing doesn't change the fact that as a general rule, elevated structures *are* safer in the event of earthquakes. The tower helps act like a pendulum, damping the impact, and the tower doesn't get the sort of lateral sheering forces of low-to-the-ground structures.

Earthquakes are *incredibly* dangerous to ground-based HSR. Both HSR and this have extremely tight tolerances on the rails. But an earthquake can shear right through a ground-based rail system. It can't do that with an elevated one as laid out by Elon.

"Musk also claims that his giant steel tube will be okay with the only expansion joints at the Los Angeles and San Francisco ends. They'll just be really big. That's a significant engineering issue that cannot simply be ignored, at least not if Musk is in any way serious about this proposal. "

I agree with this, and I sent some comments about it. That said, it's important to note that high speed rail - and presumedly this as well - involves *pre-stressed* steel. The metal is heated up when being placed and is welded hot, so that it tensions as it cools, and is anchored by very heavy objects (in the case of hyperloop, the columns). That way, thermal expansion doesn't warp the track, it just relaxes the stress. So I don't know exactly what his plans for the end expansion joints are, but the same method to keep HSR from buckling is applicable here as well.

by Nafnlaus on Aug 15, 2013 12:04 pm • link • report

Oh, and as for land aquisition: total land aquisition for the route (not counting stations) outside of I-5 is... wait for it... 43.7 miles. That's all. Now, it's been described as scandalous that Feinstein's husband got $35 million per mile compensation for rail, and hyperloop has a *dramatically* smaller footprint than rail (orders of magnitude) - but let's just go with that figure. 35 million per mile... 43.7 miles... why, in this worst case scenario, that's 1 1/2 billion dollars! Musk budgets 1 billion. So tell me again why his land acquisition costs are unreasonable?

by Nafnlaus on Aug 15, 2013 12:22 pm • link • report

"He also owns a rocket company. Maybe it's a plan to derail the rocket industry! He also owns a solar company. Maybe it's a plan to derail the solar industry!"

except he doesnt start the paper by knocking those industries. he does by knocking CAHSR.

"But the Hyperloop doesn't actually make it to downtown LA or downtown San Francisco."

"Like an airport. Remember, he said this is something sort of in-between rail travel and air travel."

but he suggests this is a substitute for CAHSR, and cheaper. Its advantages over air, and part of its costs, are due to downtown access.

"That's a rule for *human controlled* systems. Automated carpool trains can drive literally milliseconds apart from each other. This 30 seconds is IMHO a huge margin of error, likely driven more by airflow issues than safety ones."

automated systems never have collisions? Are there working systems, carrying passengers, with these tolerances?

by AWalkerInTheCity on Aug 15, 2013 12:22 pm • link • report

To sum up: I think a lot of people saw his cost figures and immediately went into "disbelieve mode", without taking the time to learn out why they're as low as they are.

To sum up:

* The system (net mass of track plus loaded vehicle) is really small and light compared with a loaded train and what is needed to support it.
* Because it's so small and light:
** ...the materials costs are reduced
** ...it makes it cheap to tunnel
** ...it makes it cheap to elevate
* Because it's elevated...
** ...it fits into the median and largely eliminates land acquisition costs and greatly simplifies environmental approval (the two biggest costs)
** ...it has minimal footprint on the little non-highway land it does have to go across, thus making acquisition and environmental approval cheaper and easier than surface-based rail.

That's why the numbers come up so cheap.

by Nafnlaus on Aug 15, 2013 12:31 pm • link • report

@AWalkerInTheCity:

"except he doesnt start the paper by knocking those industries. he does by knocking CAHSR."

Well, it's a pretty big target. And it's not hard to see how his proposal could be expanded to meet CAHSR's capacity - in fact, the paper does that in the end. But since this would be the first line *in the world* ever built, it's of course prudent first begin with one leg (the most in-demand one).

"Its advantages over air, and part of its costs, are due to downtown access."

Huh? No, it's advantages over air are that it costs $20 and leaves every 30 seconds and takes half an hour and powers itself without carbon emissions.

"automated systems never have collisions? Are there working systems, carrying passengers, with these tolerances?"

Yes, they are. And, more to the point, by comparison, CAHSR trains are to leave every two minutes. You really think a *fully loaded train going hundreds of miles an hour* can stop in two minutes?

by Nafnlaus on Aug 15, 2013 12:39 pm • link • report

.it makes it cheap to tunnel

Yet his tunnel costs are still too low.

...it fits into the median and largely eliminates land acquisition costs and greatly simplifies environmental approval (the two biggest costs)

You think that an elevated structure has simpler approvals? Uh, no.

For anything, be it a road or a train track or a pipeline or whatever, if it costs X to build it along the ground, it's going to cost about 2X to build it above ground and about 4X to put it underground.

The bottom line is this: One of the primary justifications for this is cost. The cost numbers are based on nothing but dubious assumptions. For the cost numbers to be believed, there's a whole lot more work that needs to be done, and people are rightfully skeptical about it. The burden of proof is on Musk to show that it actually can be built at the costs he claims.

by Alex B. on Aug 15, 2013 12:39 pm • link • report

@Nafnlaus:

> *And, more to the point, by comparison, CAHSR trains are to leave every two minutes. You really think a *fully loaded train going hundreds of miles an hour* can stop in two minutes?*

Actually, CAHSR trains are going to run at 12 trains per hour, which is a departure every 5 minutes.

And deceleration from 220 mph to 0 mph at a maximum deceleration of 3 mph/sec (which seems to be the standard for steel wheels on steel rails) can be done in 73.33 seconds, which is 1 minute 13.3 seconds.

by Matt Johnson on Aug 15, 2013 12:44 pm • link • report

No, I went into "disbelieve mode" before I even knew the cost. It's one thing to propose an electric car or a rocket or kind of online banking program - because we have had those for a long time. It's quite another to propose a type of transportation system that no one has ever built and that does things that no one has ever been able to do using ideas that no one has ever tested.

He's said it would help if he built a prototype. I think that is the one thing he said that you can't argue with. Build a working prototype and THEN talk about what a

larger one can do.

The fastest train ever clocked in at like 360mph on a specially built test bed. He's talking about normal operations at more than twice that speed and at nearly half the cost. That just isn't how engineering works. You don't suddenly stumble across a new technology that is twice as good at half the cost. Or at least, I can't think of an example. So yeah, this could be the first time something like that happens, but doubt it. I don't think you'll ever go broke betting against people pulling something like that off.

by David C on Aug 15, 2013 12:44 pm • link • report

"You do realize that the biggest part of the cost for such projects (both HSR and hyperloop) is land acquisition, right?"

You are wrong. See PDF-pages 88-90 of the 2012 CAHSR business plan. Land acquisition is, for full LA-SF service, 6% of the total cost. The tunnels, viaducts, grade separations, and earthworks are 48%. The largest fraction of the 2009-to-2011 cost overrun was the growth in the amount of bridging and tunneling proposed, for a variety of reasons: further environmental work busting cheaper alternatives, agency turf battles leading to overbuilding, and the realization that additional sprawl since when the maps were first published requires more grade separations.

Musk appears to believe the same as you. The proposal ignores viaduct construction costs other than in its made-up cost figure for the civil infrastructure, and dwells on ROW acquisition issues. That's sort of defensible if you're plowing a new ROW through rich suburbs, but is completely daft if you're going through farmland. This is despite the fact that the California HSR critics who've followed the project closely, like Elizabeth Alexis, have repeatedly mentioned the need for extra viaducts as proof that the HSR Authority's proposals can't be trusted.

"The pair of tubes is only $650M. Which IMHO sounds like an overestimate to me, the amount of steel being talked about should cost about $120M at $400/tonne (cheap steel), and even if you double that for precision manufacture and high quality steel, that's still a third of Musk's figure."

The material cost of concrete slabs for HSR viaducts and box girders is on the order of $1,000 per linear meter: the cross-sectional area including the box girder (which is equivalent to part of the Hyperloop pylon) is about ten square meters, and concrete costs $100 per cubic meter. The actual viaduct costs twenty to thirty times as much.

by Alon Levy on Aug 15, 2013 12:50 pm • link • report

"Well, it's a pretty big target. And it's not hard to see how his proposal could be expanded to meet CAHSR's capacity - in fact, the paper does that in the end. But since this would be the first line *in the world* ever built, it's of course prudent first begin with one leg (the most in-demand one)."

I am explaining why people are pointing out that his ownership of a car company might be a motivation, while his rocket and solar companies are not. As for a big target - yes, CAHSR has lots of issues and complexities as well big important infrastructure projects do. AFAIK Musk has never built a large infrastructure project - not even his own rocket launching facility.

I would be more persuaded of the seriousness of this, if not only musk, but all the advocates for this, would stop taking potshots at CAHSR. It sounds like you and perhaps Musk, would oppose CAHSR even if the hyperloop idea didnt exist. Thats why this sounds like "dont build the purple line, because of Google cars"

"Its advantages over air, and part of its costs, are due to downtown access."

"Huh? No, it's advantages over air are that it costs $20 and leaves every 30 seconds and takes half an hour and powers itself without carbon emissions."

I was referring to the advantage of CAHSR over air.

"automated systems never have collisions? Are there working systems, carrying passengers, with these tolerances?"

"Yes, they are."

Please link.

"And, more to the point,"

why is that not to the point?

by AWalkerInTheCity on Aug 15, 2013 12:51 pm • link • report

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*That's a rule for *human controlled* systems. Automated carpool trains can drive literally milliseconds apart from each other. This 30 seconds is IMHO a huge margin of error, likely driven more by airflow issues than safety ones.*

Is there a single computer-controlled transportation system in existence that does not leave safe emergency braking distance between vehicles? Driverless metros operate with enough space between that if a vehicle stops abruptly the following vehicle can stop. Anything else is a recipe for disaster.

As for:
Automated carpool trains can drive
CAN drive? DO drive? Got a working example of this? Oh wait, it's just more theoretical future tech mumbo-jumbo. I mean, you COULD do this, but as soon as I throw a basketball into the road you'd have a 500-car pileup.

by MLD on Aug 15, 2013 12:54 pm • link • report

".it makes it cheap to tunnel Yet his tunnel costs are still too low."

So you assert. Yet you don't back it up. Find an example of a pair of 7-foot bores in a non-environmentally-sensive area costing dramatically more than Musk's figures, and then I'll start to take your assertion seriously.

"For anything, be it a road or a train track or a pipeline or whatever, if it costs X to build it along the ground, it's going to cost about 2X to build it above ground and about 4X to put it underground."

First off, reference? Secondly, *it's in a median*. You can't be having a negative environmental impact because it's *already not a natural environment*. The environmental impacts of *bulldozing the whole place flat and running tens of thousands of exhaust-spewing vehicles per hour through there* were already studied and approved.

Musk has a whole paper that's clearly had a great deal of work put into it and a solid track record when it comes to implementation of radical ideas. You have bold assertions that he's wrong without anything to back them. So who do you think wins in the comparative analysis here?

by Nafnlaus on Aug 15, 2013 12:54 pm • link • report

@Nafnlaus
I suggest you read Alon's post about it, it has lots of numbers sourced that you are complaining about:
http://pedestrianobservations.wordpress.com/2013/08/13/loopy-ideas-are-fine-if-youre-an-entrepreneur/

"This is researched, and you're just asserting!" is wrong. It's assertions based on actual infrastructure costs, which the hyperloop paper seems to ignore.

by MLD on Aug 15, 2013 1:00 pm • link • report

"You an't be having a negative environmental impact because it's *already not a natural environment*.

youve never been involved in enviro impact analysis for an urban mass transit project, have you? Environmental Impact is NOT limited to natural environments.

"Musk has a whole paper that's clearly had a great deal of work put into it and a solid track record when it comes to implementation of radical ideas. "

he built electric cars which folks did before, and its not clear how successful the company will be. he created a private company to do what govts had done before, for years, but cheaper. Neither of those is implementing a technological leap such as this is claimed to be.

And neither involved building a major infrastructure project.

Again, this could be taken more seriously if its supporters did not constanly appeal to authority - "dont worry your little heads, because Mr Musk is smart"

by AWalkerInTheCity on Aug 15, 2013 1:00 pm • link • report

"No, I went into "disbelieve mode" before I even knew the cost. It's one thing to propose an electric car or a rocket or kind of online banking program - because we have had those for a long time."

Really? We've had mass-produced electric cars popular among the public which can go hundreds of miles on a charge and outperform a Ferrari for a long time? We've had rockets produced by a private start-up company for a couple percent the cost of NASA's which can beat NASA at its own game? Wow, I must have been in a different world all this time.

Quit playing down Musk's achievements. These are pretty radical things he's pulled off by any standards.

"Build a working prototype and THEN talk about what a larger one can do."

Building a prototype without a larger purpose planned out for it is an idiotic proposal. You spec, you prototype, then you change the spec as needed. He spec'ed, he plans to prototype next. So why the criticism?

"The fastest train ever clocked in at like 360mph on a specially built test bed. He's talking about normal operations at more than twice that speed and at nearly half the cost."

Because *it's not a train*. It's more like an airplane than a train in many regards, and the fastest aircraft, the X43-A, clocks in at 7000 miles per hour.

"That just isn't how engineering works. You don't suddenly stumble across a new technology that is twice as good at half the cost."

Except he did far more than twice as good / half the cost with both Tesla Motors and SpaceX. So yeah, he has a track record of pulling these sorts of things off.

by Nafnlaus on Aug 15, 2013 1:01 pm • link • report

Regarding the environmental analysis, it's important to note that this proposed project is in California.

If you think an EA/EIS is bad here, you haven't met CEQA. Apparently, they have to do CEQA analyses when they restripe a road to have a bike lane. Just paint. Not even the use of shovels.

by Matt Johnson on Aug 15, 2013 1:03 pm • link • report

"Because *it's not a train*. It's more like an airplane than a train in many regards, and the fastest aircraft, the X43-A, clocks in at 7000 miles per hour."

aircraft do not operate in tubes, powered by linear induction motors, with tight headways between them.

Which is not to say it won't work - but its much more different from an airplane than a Tesla is from a Volt, or than Space X is from Arianne.

by AWalkerInTheCity on Aug 15, 2013 1:06 pm • link • report

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*First off, reference? Secondly, *it's in a median*. You can't be having a negative environmental impact because it's *already not a natural environment*. The environmental impacts of *bulldozing the whole place flat and running tens of thousands of exhaust-spewing vehicles per hour through there* were already studied and approved.*

Ah yes, it's easy to lower costs in one's mind when you simply ignore the law.

I'll give you a hint: the word 'environment' in the hands of the California Environmental Quality Act or the National Environmental Protection Act does not mean what you think it means.

by Alex B. on Aug 15, 2013 1:08 pm • link • report

"You are wrong. See PDF-pages 88-90 of the 2012 CAHSR business plan. Land acquisition is, for full LA-SF service, 6% of the total cost. The tunnels, viaducts, grade separations, and earthworks are 48%."

Funny, because I'm looking at your paper and I see section 40 as the total land acquisition cost (not just the raw dollar figure for the purchase itself), which for SF to LA/Anaheim is about $12.5B out of about $58B, or about 22% of the total. But that in turn is still only a fraction of the cost, because resistance to that acquisitition (legal) will make up most of section 80 ($5.5B), and all of the environmental issues get wrapped up in section 10 ($27B), and of course all of this contributes to section 90 (contingency).

"further environmental work busting cheaper alternatives"

Thank you for making my point for me.

"agency turf battles leading to overbuilding"

Weren't you and other opponents just using the overbuilding to argue against hyperloop, saying it doesn't have the coverage of HSR?

"and the realization that additional sprawl since when the maps were first published requires more grade separations."

Which, of course, gets wrapped up in the other costs, rather than being a cost on its own.

"That's sort of defensible if you're plowing a new ROW through rich suburbs, but is completely daft if you're going through farmland."

This is funny because in most of these debates I've been swarmed by opponents arguing an opposite tack, that farmers will fight hyperloop in their land tooth and nail.

"The material cost of concrete slabs"

So I take it you're not contesting Musk's steel figures. Good.

"... for HSR viaducts and box girders is on the order of $1,000 per linear meter: the cross-sectional area including the box girder (which is equivalent to part of the Hyperloop pylon)"

The hyperloop pylons are carrying far less weight per mile of track. There's absolutely no reason they should cost the same per mile as HSR. I find that a ridiculous argument to make.

by Nafnlaus on Aug 15, 2013 1:21 pm • link • report

"The system is really small and light compared with a loaded train"

His steel tube can't be anywhere near quite as small and light as a bicycle path, but his supposed viaduct cost per mile is approximately what it costs to build a bike bridge.

by Payton on Aug 15, 2013 1:31 pm • link • report

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http://green.autoblog.com/2013/02/05/tesla-model-s-vs-chevy-volt-drag-race-ends-exactly-how-you-think/

http://www.greencarreports.com/news/1084138_tesla-model-s-vs-chevy-volt-owner-compares-electric-cars

so 2013 tesla model S vs chevy volt. Tesla is 2X as expensive, but about 40% faster. Thats hardly twice the performance for half the price.

by AWalkerInTheCity on Aug 15, 2013 1:41 pm • link • report

"Is there a single computer-controlled transportation system in existence that does not leave safe emergency braking distance between vehicles?"

That's not what I said. There is always safe braking distance. "Safe braking distance", however, does not mean "time to stop if the vehicle in front INSTANTLY lost all of its inertia". That's an impossibility. A moving object can't just instantly stop like that.

" Driverless metros operate with enough space between that if a vehicle stops abruptly the following vehicle can stop."

Subways are rather backwards with scheduling, relying on an old block-based approach (although that is slowly changing). ATC is a better model to look at. Airplanes are not instructed to change speed based on where another plane is, but where a plane *will be*. Because inertia exists; planes can't just suddenly stop moving in the event of an accident. The exact same is true here.

As for:

"CAN drive? DO drive? Got a working example of this? Oh wait, it's just more theoretical future tech mumbo-jumbo."

No, CAN drive.

http://www.media.volvocars.com/media/images/low/45731_1_5.aspx

That's from the SARTRE project. On a public road. Not closed. CAN. Commercially availalble, no, extant, YES. And that's a far, far harder problem than an entirely enclosed, entirely computer controlled, weatherproof system.

by Nafnlaus on Aug 15, 2013 1:54 pm • link • report

I don't think anyone is saying that he shouldn't prototype it. I'd love to see it. But rather that an as yet unproven technology cannot really be put in a one-to-one comparison with known systems that already function around the world. And certainly that they can't be entertained as criticism of the the CASHR plan until there is a realistic prototype of his system.

by Alan B. on Aug 15, 2013 1:54 pm • link • report

"The second operational cargo resupply mission to the International Space Station took place on March 1, 2013. At 10:10 EST, a Falcon 9 v1.0 was launched carrying 575 kg of cargo for the astronauts aboard the ISS. Once in orbit, three of the four reaction control system (RCS) thruster pods on the Dragon capsule needed to dock with the ISS failed to initially start up due to a low oxidizer pressure condition. Shortly afterwards, SpaceX announced that the problem had been resolved and a stuck valve had been freed allowing full oxidizer pressure and normal thruster operation. The Dragon capsule berthed with the ISS on March 3.[17]"

shit happens.

by AWalkerInTheCity on Aug 15, 2013 1:58 pm • link • report

"so 2013 tesla model S vs chevy volt. Tesla is 2X as expensive, but about 40% faster. Thats hardly twice the performance for half the price."

Bzzzt, sorry, but Tesla came before the Volt. Their first vehicle was the Tesla Roadster, so you need to compare the Tesla Roadster with EVs from before the Tesla Roadster. The most advanced EVs from before the Roadster were probably the EV1 and the RAV4 EV. The Roadster's sales price was little more than the unsubsidized production price of the EV1 or RAV4EV (they were sold cheaper, but their production costs were each over $80k, and that's not accounting for profit if anyone ever wanted to sell them profitably). It had 2.5 times the range and less than half the 0-60 time of the EV1, even better for the RAV4.

And as for SpaceX? NASA spent $3 billion on its Ares rocket and got... nothing. Despite having huge amounts of existing infrastructure and and established team. SpaceX built everything from scratch and succeded, for a grand total of $200m. Something no private company had ever done before.

So yes, Musk DOES have a track record of pulling off these kinds of achievements.

by Nafnlaus on Aug 15, 2013 2:00 pm • link • report

So yes, Musk DOES have a track record of pulling off these kinds of achievements.

And no one is stopping him. Until he or someone else pulls it off at the costs he says then it's prudent to regard this with a sceptical eye.

by drumz on Aug 15, 2013 2:02 pm • link • report

"His steel tube can't be anywhere near quite as small and light as a bicycle path, but his supposed viaduct cost per mile is approximately what it costs to build a bike bridge."

When's the last time you saw a 500 mile bike bridge over land? Or are you pretending that mile after mile of precisely the exact same structure with no additional overhead costs the same as the per-mile overhead on a bike bridge which usually only runs a quarter mile or less, and generally exists to solve a problem of challenging terrain of some kind (whether manmade or natural)?

by Nafnlaus on Aug 15, 2013 2:05 pm • link • report

We've had mass-produced electric cars popular among the public which can go hundreds of miles on a charge and outperform a Ferrari for a long time?

We've had mass-produced cars and we've had electric cars. And mass-produced hybrid-electric cars that have been far more popular (and far more mass-produced) among the public. How popular is Tesla anyway? How many Tesla's have been sold. I think they sold more Yugos than Tesla has sold. And many electric cars have a range as good or better than Teslas. As for beating a Ferrari, who cares?

We've had rockets produced by a private start-up company for a couple percent the cost of NASA's which can beat NASA at its own game?

No. And we still don't.

Building a prototype without a larger purpose planned out for it is an idiotic proposal.

Creating a white paper without the plan to build a prototype is a pretty idiotic proposal.

*Because *it's not a train*. It's more like an airplane than a train in many regard*

Airplanes don't run on tracks. And they have wings. And jet engines. And use lift. This is not like an airplane at all.

It's much more like a magleve train. Because that's what it is.

by David C on Aug 15, 2013 2:07 pm • link • report

Except he did far more than twice as good / half the cost with both Tesla Motors and SpaceX.

By which measure are those "twice as good"? And half the cost of what?

by David C on Aug 15, 2013 2:09 pm • link • report

My understanding is that SpaceX s main competition is Ariane. NASA's problems do not show that Space X is revolutionary.

as for the tesla roadster, it did beat others to market, but the concepts were all being developed at roughly the same time

http://en.wikipedia.org/wiki/Electric_car#1990s_to_present:_Revival_of_interest

http://en.wikipedia.org/wiki/Nissan_Leaf#History_of_development

by AWalkerInTheCity on Aug 15, 2013 2:10 pm • link • report

Dave

they say they are constrained by production. They finally made a profit, though not under GAAP. their sales are higher than the Volt, but lower than the Nissan Leaf.

Two cheers for visionary Japanese entrepreneurship.

by AWalkerInTheCity on Aug 15, 2013 2:15 pm • link • report

Hi Matt,

The actual PDF for the concept never says 30 seconds between departures.

Page 11, under "Hyperloop Passenger Capsule"
lists the average departure time of 2 minutes between capsules for a total of 840 passengers per hour.
http://www.spacex.com/sites/spacex/files/hyperloop_alpha-20130812.pdf

by Ben Frison on Aug 15, 2013 2:29 pm • link • report

Actually, a review of SpaceX found that developing the Falcon cost about $300 million to get to the first test launch. But that's as a developer (fixed price) - not as a customer (cost plus). If SpaceX wants to make any money, they have to charge more than that for the product, and so that's the price NASA would pay (NASA doesn't build rockets, contractors or suppliers do).

The Augustine Commission said that the ARES 1 cost $445 million to develop. Part of that is company profit. Part of that is that the ARES I would carry 2.5 times as much

weight into space.

That's still impressive by SpaceX. Many have tried to do what they've done and come up short. But it's still not twice as good at half the price.

by David C on Aug 15, 2013 2:36 pm • link • report

"When's the last time you saw..."

I was seriously looking forward to reading about your superior point of reference. And was being generous by not comparing the cost to, say, the $350M/mile that Japan's maglev will cost. Which, even if this proposal is "2X as good at 1/2X the cost," that's one heck of a long way from being 2.5X as fast at 1/20X the cost.

by Payton on Aug 15, 2013 2:43 pm • link • report

Nafnalus, you don't know what you're talking about.

Namely:

"Subways are rather backwards with scheduling, relying on an old block-based approach (although that is slowly changing). ATC is a better model to look at."

ATC systems still have headways that assume the train ahead could come to an instantaneous stop at any time. Even the fancy driverless ones.

Likewise, ROW isn't 22% of the cost. The category you're thinking of includes "sitework" and "existing improvements." The environmental work is actually hardest and most overrun-prone in areas that are ecologically sensitive or have tunnels and viaducts. The environmental work-induced cost overrun was in unpopulated areas in Soledad Canyon and Pacheco Pass. NIMBYs are for the most part a distraction, who project boosters like to put forth as a bogeyman for why their pet projects go over budget. CAHSR is actually saving money slicing through farmland instead of going elevated above existing transportation corridors.

The expensive real estate, at any rate, is in the cities, which Hyperloop avoids completely since it would be prohibitively expensive for it (but not for conventional HSR) to build Sylmar-LA and Dublin-SF.

"First off, reference? Secondly, *it's in a median*."

First, look at the California HSR itemized costs, or at papers comparing at-grade, elevated, and underground costs of urban rail. For an unfortunately old academic reference, see here. And second, nobody outside the US builds HSR in medians - they build them alongside freeway carriageways rather than between them, since they're freer to follow their own curves when necessary that way. Florida HSR and Xpress West were meant to curve with the roads they'd follow, losing speed. Hyperloop can't, requiring more viaducts, crossing over the inner carriageway at an awkward angle.

"The hyperloop pylons are carrying far less weight per mile of track. There's absolutely no reason they should cost the same per mile as HSR. I find that a ridiculous argument to make."

Not "far less." Somewhat less - the box girders aren't directly comparable. But costs don't scale with weight. Musk doesn't believe they do, either: the proposed tube cost of the larger-diameter version is 24% than that of the smaller-diameter version despite having 60% more tube mass per unit of length. And yet somehow a small weight difference - a factor of maybe 2 for the slabs (it's 6 counting the incomparable box girder) - turns into a factor-of-10-to-15 cost difference.

by Alon Levy on Aug 15, 2013 2:57 pm • link • report

@Ben Frison:

> *The actual PDF for the concept never says 30 seconds between departures.*
>
> *Page 11, under "Hyperloop Passenger Capsule"*
> *lists the average departure time of 2 minutes between capsules for a total of 840 passengers per hour.*
> *http://www.spacex.com/sites/spacex/files/hyperloop_alpha-20130812.pdf*

Actually it does. On Page 6.
"The total trip time is approximately half an hour, with capsules departing as often as every 30 seconds from each terminal and carrying 28 people each."

It also says it on Page 9.
"Sealed capsules carrying 28 passengers each that travel along the interior of the tube depart on average every 2 minutes from Los Angeles or San Francisco (up to every 30 seconds during peak usage hours)."

by Matt Johnson on Aug 15, 2013 3:17 pm • link • report

> *The Hyperloop pods will travel at up to 760 miles per hour, just under the speed of sound, with pods traveling about 30 seconds apart in the tube. They will have a maximum deceleration of 0.5 gs, which is equivalent to 10.9 mph per second. At that rate of braking, it will take a pod 68.4 seconds to come to a full stop.*

At a constant rate of deceleration, the following train has 60 seconds to stop, not 30, because the average speed during deceleration is only half-speed (380mph, not 760mph). So a modest deceleration of 0.57 G's is sufficient to avoid a collision, even with 30-second spacing. Basic physics, people.

by Ben Weiss on Aug 15, 2013 4:07 pm • link • report

Ben Weiss: Your math is not right. The midpoint is not what's relevant. It's not the average speed that matters but the time to get from full speed to no speed.

Acceleration is in length per time squared, or in metric, meters per second per second. Speed is in meters per second. So you start at one amount of meters per second and end at another (here, zero), and meters per second per second is how fast your meters per second changes.

If the capsule is going 760 mph, that's 335 meters per second: https://www.google.com/search?q=750+miles+per+hour+in+meters+per+second.

To get from 335 to zero therefore is 335 m/s / 30s = 11.2 m/s^2.

One g is about 9.8 m/s^2, so this is about 1.14 gs.

To do it in 0.5g (4.9 m/s^2) you have 335 m/s / 4.9 m/s^2 = 68.4 seconds.

Which happens to be what Matt said. So his numbers are correct. If one capsule catastrophically stops instantly, the capsule behind will have to be able to decelerate at at least 1.14 gs not counting reaction time.

Maybe there can be an emergency brake that decelerates it faster than the regular braking system, but definitely there has to be such a thing or else if one capsule crashes, one 30 seconds behind it will too.

by David Alpert on Aug 15, 2013 4:41 pm • link • report

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335 m/s
30 seconds apart
10,000 meters apart

at a little over .5 gs the second pod can stop in 10,000 meters(and 60 seconds) and hopefully avoid the collision.

by Richard B on Aug 15, 2013 5:44 pm • link • report

David, you are wrong. See Richard's response. 30 seconds at 760mph (340 meters per second) implies a 10.2km separation between capsules. If the capsule in front of you suddenly crashes, you need to stop yourself in 10.2km; it doesn't matter exactly how long that takes, as long as you do it. Braking from 760mph to zero at 0.6g takes roughly 58 seconds and has a total stopping distance of 9.8km, plenty to avoid a collision.

If you don't trust me, try a calculator: http://easycalculation.com/engineering/civil/vehicle-stopping-distance.php
The coefficient of friction corresponds to the deceleration in G's. Try plugging in 340m/s (760mph) and a coefficient of friction of 0.6 (0.6g deceleration), and you'll see a stopping distance of 9823m.

by Ben Weiss on Aug 15, 2013 7:05 pm • link • report

"All of that has to happen in less than 30 seconds (if Musk is to be believed) or 80 seconds if vehicles are kept a safe distance apart."
He can split the tube into 16 or 32 airlocks at the station and get all the time required.

They will be no doubt containing space to hold all pods at each end anyway while tube maintenance occurs.

by Wriggly Braggins on Aug 16, 2013 8:34 am • link • report

I have yet to see anyone address the matter of emergency egress from this claustrophobic disaster in waiting. This article posits a collision in the tube, how does one get out? How do emergency personnel get in? Any sort of periodic hatch system with the necessary seals both increases the cost of the main tube very significantly and makes the whole thing more prone to leaks.

This is indeed vapourware, manifestly unsafe, it would never get approval to build.

by Michael on Aug 16, 2013 9:35 am • link • report

"They will be no doubt containing space to hold all pods at each end anyway while tube maintenance occurs."

Given that it's clearly one gigantic pressure vessel, with no intermediate valves or anything, how long would it take to safely open the tube interior to the atmosphere for work and then repressurize the whole system?

by Another Nick on Aug 16, 2013 11:23 am • link • report

@Another Nick

Yeah, there are many issues like that which are trivialized in the white paper on the Hyperloop. Their vacuum "design" such as it is, is naive at best and way underestimates the cost and maintenance issues that would be involved in just having the tube evacuated and held, never mind with pods rushing through it.

by J Roam on Aug 16, 2013 3:59 pm • link • report

There is a reason why the Vactrain idea (from the 70s!) never went anywhere.

by MLD on Aug 16, 2013 4:24 pm • link • report

This is nothing more than revived Personal Rapid Transit "use pods so you don't have to sit next to black people on your daily commuting trips" nonsense that politicians like Michele Bachmann favor.

Ever wonder why PRT is the most popular mass transit "option" among Republicans and Glibertarians and certain unethical Greens? Two reasons:

1) For the stupid among them that actually think it can be made to work and work well, the selling point is based on racism. PRT/hyperloop promises not having to sit next to people who aren't exactly like you when you let someone drive you to work.

2) For the more cynical and profit-focused persons (such as persons with a vested financial interest in killing off alternatives to automobiles - you know, like the owners of car companies?), the goal is to use PRT/hyperloop proposals to keep genuine and shovel-ready mass transit projects from being built. Here's how that works:

The idea is that the mere presentation of PRT as a "better" option will be enough to kill the real mass transit project outright; if that doesn't work, Plan B is to con various local and state governments into throwing money at PRT -- money that is taken from real mass transit options, thus making it harder for those options to get built or be maintained. (Of course, Plan B provides opportunities for those persons working grifts to pick up nice fat "consultant fees", so there's that motivation as well.)

by Phoenix Woman on Aug 17, 2013 10:22 am • link • report

I'm a Republican and the last thing that entered my mind (or rather, never even occurred to me) was "great, no black guy sitting next to me!" when I was in Morgantown using their weird little Logan's Run pod PRT thingie.

I was too busy thinking "wow, a thing that marries all the advantages of the personal automobile with all the disadvantages of a subway, combined with a general feeling that a guy with a blinking hand crystal will be running by any second now. No wonder literally no one else has one of these!"

by Another Nick on Aug 17, 2013 12:12 pm • link • report

We are already having enough trouble with NIMBYs and high-speed rail as it is right now. All of a sudden, we're faced with someone who wants to build an entirely NEW form of infrastructure, with long lines clear across the country, as well as stations, etc. That's a lot of money, right there. It may be doable, but I doubt the USA has the political stomach for it, with NIMBYism and fiscal conservativism having a lot of strength.

by Richard Rabinowitz on Aug 17, 2013 10:16 pm • link • report

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I have a better idea for Hyperloop. Disney ought to run it as a ride in EPCOT-Future World, perhaps in Test Track or maybe around Mission:Space. Or maybe put it in Disneyland's California Adventure.

by Richard Rabinowitz on Aug 17, 2013 10:27 pm • link • report

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"Really? We've had mass-produced electric cars popular among the public which can go hundreds of miles on a charge and outperform a Ferrari for a long time? We've had rockets produced by a private start-up company for a couple percent the cost of NASA's which can beat NASA at its own game? "

What are you, an MBA who reads TechCrunch and is trying to sell us on Musk because you work for him?

A Tesla Roadster can't out-perform a cheaper Lotus Elise (the car it is heavily based on) on a course or even a quarter mile (straight line) let alone a Ferrari.

They can't beat NASA at their own game because contractors like SpaceX build these things for NASA, and wow are they really more cost efficient than the 40 year old Delta?

-

"There is a reason why the Vactrain idea (from the 70s!) never went anywhere."

Never say never, electric cars are starting to take off (somewhat) 100 years after they were first invented.

-

"This article posits a collision in the tube, how does one get out? How do emergency personnel get in? Any sort of periodic hatch system with the necessary seals both increases the cost of the main tube very significantly and makes the whole thing more prone to leaks."

Clearly you haven't considered the idea of Teleportation. I'm not optimistic about it seeing as Musk prefers to evolve ancient technology fields rather than invent new ones.

-

"This is nothing more than revived Personal Rapid Transit "use pods so you don't have to sit next to black people on your daily commuting trips""

If someone is afraid of certain kinds of people than they can sit in a different part of the train, like what some people do with my scary white self here in Japan.

by TokyoMG on Aug 17, 2013 10:59 pm • link • report

@RichardB @Ben Weiss
While its feasible at .6G that doesn't mean its realistic or would pass any sort of safety engineering review mostly because it assumes instant reaction (or near-instant). That is the following car would have to be notified immediately of the hazard and each 1s dealy would entail the loss of 340m...or with Ben's numbers 10163m with a 1s dealy which is dangerously close to the 10200m separation. Anything greater than a 1s delay from incident to activation of the emergency braking and that's at .6G and not the .5G they talk about. At .5G from 340m/s you get a stopping distance of 11787m which is too much far and away.

At 340m/s you would need a minimum of .58g AND perfect reaction time. With 1s delay you'd need .6g minimum and .62g with a 2s delay. They talk about .5G acceleration but don't mention the braking power anywhere but it better be greater than the acceleraiton power or the headways need some serious re-thinking.

by Greg on Aug 18, 2013 12:33 am • link • report

I'm not a transport expert, but I am someone who does the LA to SF commute at least once-a-month.

I don't think capacity is a big issue: I can't see HSR running anywhere close to capacity. The flight on virgin costs $59 (if you catch a fare sale $49) and takes 1hr 5min. HSR is promising 2hr 50min for about $105.

Why would anyone outside the rural area in-between (or people afraid of flying) ever take the train instead of flying?

Also, most of the folks in tech and media who do the commute regularly live a lot closer to LAX than to Union Station. I agree that hyperloop would have to come all-the-way into the cities.

Then again, if I could do the trip in ~30 min for under $59, I'd probably do it every 1-2 weeks. It'd be a complete game-changer.

by Dan on Aug 18, 2013 11:29 am • link • report

First, don't discount Elon Musk.

Second, the canonical mode of train TODAY from Los Angeles to San Francisco is the AIR PLANE. Where was that is your crazy analysis??

Hyperloop beats airplane hands down.

Q.E.D.

by fred on Aug 18, 2013 12:59 pm • link • report

Don't know why the others bother to comment. Is everybody here still in high-school??

by Yan Neyr on Aug 18, 2013 2:00 pm • link • report

Why would anyone outside the rural area in-between (or people afraid of flying) ever take the train instead of flying?

And, right now, the average flight time between DCA and LGA is about the same - yet Amtrak, even with slow trains, has a much larger share of the travel market between New York and DC.

Flight time isn't the relevant metric. Not when you need to get to the airport, check in, go through security, etc. - all of which take up a lot of time.

by Alex B. on Aug 18, 2013 2:07 pm • link • report

I don't believe that Musk's proposal called for pods to be traveling in the tube 30 seconds apart, rather, they would be leaving the station 30 seconds apart (and likely arriving at the destination station 30 seconds apart). The distance between the pods would be greater during the high speed portion of the trip however as pod A would be accelerating away from the departure station and would continue to build up a distance cushion from pod B until both were traveling at the same speed. The distance between them would close during the deceleration phase but speeds would be lower, thus requiring less braking in an emergency stop situation. The average separation between capsules in the spec is listed as 23 miles, which would be just under 2 minutes at full speed but as I've explained, the distance during the high speed portion of the trip would be greater. This is ample time to bring a capsule to a full stop from full speed in an emergency situation.

Having three pods at each station for loading/unloading allows for approximately 5 minutes for same during normal operations. I don't see a problem with this. Logistics

could also be set up in such a way to prevent this bottleneck in the case of a passenger requiring more time or if we are running at peak capacity. You could simply add additional loading/unloading stations. Pods could also be designed in such a way that entry and exit could be accomplished by all 28 passengers simultaneously. This could easily take far less than 5 minutes per capsule.

Also, acceleration and deceleration are not limited to .5g in the spec, that is the lateral acceleration (going around bends). Many performance cars can safely exceed this spec today.

As for capacity concerns - the hyperloop system's design allows for scaling capacity to passenger count. HSR requires sending a train out on a schedule whether it is full or not. With Hyperloop, if you have more passengers than you have capacity, then you simply queue them up. The wait time would likely still be significantly less than a trip via HSR even if we exceed the 3360 passenger per hour max in the spec. How many passengers will HSR be able to carry per load? How often can you run trains?

I won't speculate as to construction cost advantages for Hyperloop, however I am fairly confident that the California HSR project will far exceed its projected cost, perhaps by some multiple.

Is Hyperloop ready to build today, clearly not, but I don't see any unsolveable problems with it.

by Steve on Aug 19, 2013 12:38 am • link • report

Steve,

30 seconds is 30 seconds. The time gap between pods will remain the same.

Also, acceleration and deceleration are not limited to .5g in the spec, that is the lateral acceleration (going around bends). Many performance cars can safely exceed this spec today.

Sure, and no one was suggesting that it would be an unsafe level of G-force. But it damn sure would be uncomfortable. Consider the guys that design and build maglevs:

http://www.theverge.com/2013/8/16/4626506/speed-bumps-and-vomit-are-the-hyperloops-biggest-challenges

At 750mph, even a gentle curve jerks passengers to the side. In physics, it's known as lateral G-force, and the human body can only take so much before motion sickness sets in. As a result, planners are always balancing the curviness of their route with their traveling speed and the level of G-force passengers can withstand. Musk's planned route is designed to limit lateral G-forces to a maximum of 0.5 Gs, which lets the proposed Hyperloop path follow I-5 at 760mph, and blaze through the first 14 miles outside of Los Angeles in just under three minutes. The 0.5 G limit lets Musk draw a windier path through California, but it's significantly higher than any existing transportation project.

According to Powell, that's a problem: "In all our tests, we found people started to feel nauseous when you went above 0.2 lateral Gs." The closest comparison would be roller coasters, which usually top out around half a G — but the Hyperloop wouldn't just peak at 0.5; it would stay there for the duration of the curve. The result would be well short of blackout, which most studies peg around 4.7 lateral Gs, but it would make the Hyperloop challenging for the faint of stomach. A sick passenger might be less catastrophic than a crash but, given the tight passenger compartments, the results could still be fairly traumatic.

You're not hopping on to a train here, you're going to get strapped in to your seat like you were on a 35 minute roller coaster ride.

How many passengers will HSR be able to carry per load? How often can you run trains?

Did you read the article? Your answer is there. And it's a lot more than the Hyperloop's capacity.

by Alex B. on Aug 19, 2013 8:58 am • link • report

"Flight time isn't the relevant metric. Not when you need to get to the airport, check in, go through security, etc. - all of which take up a lot of time."

Exactly. I used to live in a pretty rural place and we'd drive long, out of state, distances just because it was time competitive. For instance, it's an hour flying time from the airport nearest my parent's house to DC. However, its a 90 minute drive to the airport, take about half an hour to actually get into the airport (parking, etc), gotta be there an hour early for security and everything, fly an hour, another half hour to get from the gate to curbside, and then...let's be generous and say there's no traffic so it takes my parents another half hour to get to my place. So they just took five hours to get from their place to mine. Or they can drive it in five and a half.

by Another Nick on Aug 19, 2013 12:04 pm • link • report

@Steve:
The stopping distance math can be hard to wrap your mind around. While the vehicles would only catch up with each other as the first starts to decelerate into the terminal, the stopping distance *does* catch up.

Let me explain. I built a model so we can see real numbers:

Let's assume Pod A leaves Sylmar at 7:00:00. Pod B, following, leaves Sylmar 30 seconds later at 7:00:30.

At the moment Pod B leaves Sylmar, Pod A is 1.49 miles ahead, going 300 mph.

Pod B reaches 300 mph at 7:00:59 (29 seconds in) and Pod A ahead is also traveling 300 mph. At this point, the capsules are 2.58 miles apart, and Pod B can stop in 1.389 miles at 0.5 gs.

That separation/stopping distance remains the same as long as both vehicles are traveling at 300 mph.

For the sake of this example, we'll assume that Pod A reaches the straightaway in the San Joaquin Valley at 7:02:00, 8.9 miles north of Sylmar. It begins to accelerate to 760 mph.

At 7:02:41, Pod A reaches its cruising speed of 760 mph. At this very moment, Pod B is traveling 420.7 mph, while accelerating to 760 mph. The separation between vehicles is now 5.13 miles, and the stopping distance of Pod B is 2.591 miles.

At 7:03:12, Pod B reaches its cruising speed of 760 mph. Pod A is also traveling at 760 mph.

The distance between the 2 pods is now 6.54 miles. The stopping distance of Pod B is 7.946 miles (including a 3 second time for the computer to react and engage the brakes). Removing that 3 second time would reduce the stopping distance to 7.313 miles.

At this point, any time both pods are traveling at 760 mph, they will be 6.54 miles apart, but the stopping distance of the following pod will be greater than that distance.

Let's assume that at 7:30:00, Pod A makes the turn toward the Bay Area and begins to decelerate to 300 mph.

At 7:30:41, Pod A reaches 300 mph. At that moment, Pod B is traveling 639.3 mph, also decelerating. The distance between the pods is 3.99 miles. The stopping distance of Pod B is 5.708 miles.

At 7:30:59, Pod B has decelerated to 441.9 mph. The distance between the pods is 2.82 miles. The stopping distance of Pod B is 2.84 miles.

From this point on, the stopping distance should be sufficient, tough that depends on how quickly the pod decelerates at the terminal.

So clearly, 30 seconds won't work. And if 30 seconds won't work, then the capacity that Musk claims he can provide is too high.

by Matt Johnson on Aug 20, 2013 12:40 pm • link • report

Why in the world would you assume that in an *emergency*, they system would limit itself to a "comfortable" braking speed? One might assume that in an actual emergency, some "uncomfortable" measures may need to be invoked. But that is not the real problem with your argument.

In case of an emergency, the vehicle in trouble *would itself have to decelerate*. As mentioned in the paper from SpaceX, the system would be controlled by computer. If the computer knows, in near real-time, the location and speed of every car in the system.

So Matt, while your explanation of the timing and math may be detailed and accurate, you're missing one key point: if one vehicle starts decelerating, ALL vehicles will also start decelerating. So the stopping distance for vehicles travelling at 760MPH my be greater than the distance between pods, Pod A will not go from 760MPH to 0 instantaneously. BOTH PODS will be decelerating at nearly the same time. There is enough of a buffer between them to account for "reaction time" while the entire loop powers down, as well as from the effects of a dramatic deceleration of one or more pods.

If your biggest problem with the whole thing are his claims about capacity... you can simply add another set of tubes to the pylon, and have an inner loop, and an outer loop. You would have to do that ANYWAY if you wanted to have a larger regional network. I would think that, as someone with a degree in "community planning", you would know that.

Besides *all of that*, these are solvable problems. SpaceX is a company that just demonstrated a rocket capable of launching a 10 story building 300m into the air, moving it 100m laterally, and then landing it in the exact same place it launched from. It is the only private company currently launching round-trips to the space station. They have already solved the most difficult problem, which was dealing with air compression in front of the vehicle.

Elon Musk is the Thomas Edison of our time, and he employs some of the smartest people on the planet. Together, they have already solved some amazing problems, and built some of the world's most technologically advanced systems. you have a degree in community planning. You have quite an ego on you if you think that qualifies you to debunk anything. That fact that you opened your argument with "Of course he hates trains, he sells cars!" just shows how afraid of really great ideas you truly are. And that's quite sad.

by Robert McLaws on Aug 20, 2013 1:26 pm • link • report

"Elon Musk is the Thomas Edison of our time, and he employs some of the smartest people on the planet."

Other than Paypal what has he invented that has transformed our lives? I have yet to see a Tesla on the road. SpaceX has done a couple of launches. How is this like Edison? Also I thought fans of N Tesla didnt much like Edison.

" You have quite an ego on you if you think that qualifies you to debunk anything. "

this kind of appeal to authority is not convincing.

by AWalkerInTheCity on Aug 20, 2013 1:35 pm • link • report

Robert,

The hyperloop doesn't solve any problems. Even under the most optimistic assumptions (and let's remember that they are just that: assumptions), it's a low-capacity

roller coaster ride.

And no, Musk has not proven a damn thing re: the Hyperloop. He has a nice idea for how to solve the air compression issue, but this is not built anywhere. There is no prototype. There is no proof of concept. There is no evidence that such a large piece of civil infrastructure can be built to the minute tolerances required for the 'hover gap' Musk proposes, and there is certainly no evidence that it can be done anywhere near as cheaply as he assumes (again, those pesky assumptions).

I like Musk. I think he's a great innovator. If he wants to line up some capital to build a full-scale prototype of the hyperloop, I look forward to seeing it. But SpaceX's rockets and Tesla's cars are incremental innovations built on top of existing, proven concepts. This white paper is not proof of anything.

by Alex B. on Aug 20, 2013 1:36 pm • link • report

Oh yeah, also, one would assume that good station design would use a switchtrack to on and off-load passengers, meaning that there would be a way to bypass the station and continue back around the loop in case of an emergency. That would probably involve a maintenance station somewhere on the bypass loop, similar to the Monorail system at Walt Disney World.

That might mean an extra section of track would have to be built where the turning forces might exceed 0.5Gs. But passengers passing out from the G forces on a bypass track would be preferable to the vehicle being involved in a catastrophic crash. Again, solvable problems that don't require the entire idea to be thrown out or dismissed as implausible.

by Robert McLaws on Aug 20, 2013 1:39 pm • link • report

SpaceX is a company that just demonstrated a rocket capable of launching a 10 story building 300m into the air, moving it 100m laterally, and then landing it in the exact same place it launched from. It is the only private company currently launching round-trips to the space station. They have already solved the most difficult problem, which was dealing with air compression in front of the vehicle.

Impressive, no doubt. But these are problems that had previously been solved by others. In some cases - many others and many years ago.

The hyperloop is a whole other animal. No one has ever done this. We don't even know if this is technically possible. It's the difference between a high school kid building a motorcycle from scratch (impressive) and the same kid building a motorcycle entirely with a 3D printer (very impressive).

I feel the same way about this as I do the self-driving car. I hope like hell it works. I would love to live in a world where I can travel city to city at super high speeds and incredibly low costs, just as I'd like cars that are 100% safe and will drive me when I sleep. But these things are hard and its the long tail that gets you every time. So, I'm skeptical and Musk has done little to assuage that skepticism.

by David C on Aug 20, 2013 1:39 pm • link • report

Walker: So he's not a genius because you have yet to see a Tesla S? Yeah, that makes sense. And yeah, sending rockets into space is no big deal. Anyone can do that these days.

It would be foolish of anyone to think that Musk would put a paper out like this unless computer simulations modeling real world performance had been done. Pretty sure SpaceX has the capability of doing so, and they showed stress tests on the virtual pylons in the document.

by Robert McLaws on Aug 20, 2013 1:44 pm • link • report

@Robert McLaws:
I don't think my degree in Community Planning qualifies me to debunk the Hyperloop.

I do think my BS from the Georgia Institute of Technology more than qualifies me, though.

However, my qualifications aside, the Hyperloop proposal has some serious flaws. I made my case for why it can't do as much as Musk claims for as cheap as Musk claims.

I was very careful not to address the technical feasiblity of the concept. Others have done so, especially Alon Levy. But let's assume that it is technically feasible.

If it ends up costing $600B and only moves 30% of the capacity of HSR, it will still be cool technology, but it won't be doing it as cheaply or effectively as Musk claimed it would.

Adding a second set of tubes on the same pylons would increase the cost. Maybe not by a factor of 100%, but probably somewhere in the 80% range. Of course, that assumes that the pylons were overdesigned in the first place.

My objection is that I don't think it's possible for anyone to build the Hyperloop as designed for $6B. And as it's designed, it is clearly not capable of moving as many people as HSR.

by Matt Johnson on Aug 20, 2013 1:47 pm • link • report

It is amazing to me how much effort people put into explaining why something can't be done, instead of putting that effort into solving any problems that might be preventing it from being a reality. Truly amazing. No wonder true innovation comes from so few individuals.

by Robert McLaws on Aug 20, 2013 1:50 pm • link • report

"Walker: So he's not a genius because you have yet to see a Tesla S? Yeah, that makes sense. And yeah, sending rockets into space is no big deal. Anyone can do that these days."

you said hes the edison of our time. Edison invented (allegedly) the light bulb, the phonograph, and the moving picture. All of which transformed our life.

So far the only life transforming thing from Musk is PayPal. hes a smart guy, and I dont begrudge him his money, but I dont see a record that calls for believing him because of who he is.

by AWalkerInTheCity on Aug 20, 2013 1:51 pm • link • report

"It is amazing to me how much effort people put into explaining why something can't be done, instead of putting that effort into solving any problems that might be preventing it from being a reality. Truly amazing. No wonder true innovation comes from so few individuals. "

It quite possible it can be done. The question is, however, do its charecteristics, including cost, mean that we should stop CAHSR to wait for the HyperLoop? I am all for Mr Musk continuing research on the Hyperloop. But meanwhile CAHSR should proceed.

by AWalkerInTheCity on Aug 20, 2013 1:54 pm • link • report

No one's saying the problems are insurmountable. They're saying that these things are either ignored or wrong in what Musk actually said in his paper. He can innovate all he wants and he's welcome to build it. I would hope that he would take any and all suggestions seriously as well.

And as has already been pointed out. It's still not a replacement for high speed rail.

by drumz on Aug 20, 2013 1:56 pm • link • report

It is amazing to me how much effort people put into explaining why something can't be done, instead of putting that effort into solving any problems that might be preventing it from being a reality.

Yeah!

So why doesn't Musk help the CA HSR authority work through their plans, rather than try to undercut them with a vaporware concept?

The reason people spend time debunking this stuff is because a) it has errors - Musk's assertions about high speed rail energy use are way off, and his assertion that HSR will use diesel locomotives is even more bizzare; b) proponents will swallow it hook, line, and sinker - there are Californians wanting to put the Hyperloop on a ballot initative to replace HSR... They want to replace a proven transportation technology with something that has a lower capacity and doesn't even exist.

Finally, no one is preventing this from happening. If you don't like the skepticism, there is a very easy way to earn the hearts and minds of the skeptics: build a working prototype to validate your assumptions. In other words, prove it.

by Alex B. on Aug 20, 2013 1:57 pm • link • report

Matt, my previous comment was posted before I saw your response, and was not directed at you.

So, let's say the technology is viable, and it is possible. Why do you doubt his claims? You forget one very important thing: Musk does not work for the government. He has put together a massive spacefaring company without the unlimited resources of the Federal Gov't. he has massive manufacturing capability, and a profitable car company.

We're not talking about a company that sells bar soap to Wal-Mart or something. Musk's companies make big things at scale. So I think he has a pretty good handle on how much it costs to manufacture things.

It is unlikely to have a 100x cost overrun, or even a 10x cost overrun. If it cost twice as much and still moved the same number of people, it would still be a useful thing. The Concorde had a limited capacity and a limited fleet and still enabled new scenarios for travel between Great Britain and the US that were not previously feasible.

And on the capacity point, you could build pylons that could handle 4 or 6 tubes for a marginally increased initial cost, and then add subsequent tubes later. Again, there are plenty of ways to solve whatever problems come up, because the hardest problems have already been solved.

And if you don't think I'm right, I refer you to this amazing woman: http://www.youtube.com/watch?v=ukgnU2aXM2c

by Robert McLaws on Aug 20, 2013 2:04 pm • link • report

People are wanting the HSR to be replaced with Hyperloop because some individuals recognize that great innovations have to start somewhere, even if initially they don't "carry as many passengers" or whatever. The Space Shuttle only carried 10 passengers. Anyone want to argue that wasn't a worthwhile endeavor?

by Robert McLaws on Aug 20, 2013 2:07 pm • link • report

The Space Shuttle only carried 10 passengers. Anyone want to argue that wasn't a worthwhile endeavor?

Sure it was worthwhile. But people aren't just asking for a new space shuttle here, they're asking that the thing that doesn't yet exist replace the 747.

And Musk's cost numbers for tunnels and viaducts are bogus. He's either made some serious breakthrough in civil engineering (unlikely, but possible) - in which case, the cost benefits would apply to HSR or to pipelines or to highways just as easily as the hyperloop; OR, his estimates are woefully short of reality. The latter is far more likely.

by Alex B. on Aug 20, 2013 2:13 pm • link • report

"Musk does not work for the government."

actually he does. SpaceX gets govt contracts.

"People are wanting the HSR to be replaced with Hyperloop because some individuals recognize that great innovations have to start somewhere, even if initially they don't "carry as many passengers" or whatever. "

If it doesnt get the capacity relative to cost that CAHSR does, why should CAHSR be delayed? The goal of CAHSR is to carry a large volume of people, to relieve strain on airports and highways.

If Musk is looking for a place to start, I would suggest LA-Las Vegas instead.

by AWalkerInTheCity on Aug 20, 2013 2:16 pm • link • report

Plus, we have many ways currently of getting from LA to SF. You can even take a train today! HSR is about speeding up that journey so more people take it without adding to the strain on I-5 or the air route between the cities. Moreover, we have successful exampls of HSR all over the world. Why put that on hold just to prove something about "innovation"?

Great innovations do start somewhere. I submit that Mr. Musk get to work.

by drumz on Aug 20, 2013 2:16 pm • link • report

The Space Shuttle only carried 10 passengers. Anyone want to argue that wasn't a worthwhile endeavor?

The Space Shuttle was not a worthwhile endeavor. And I used to work on it.

by David C on Aug 20, 2013 2:28 pm • link • report

If Musk is looking for a place to start, I would suggest LA-Las Vegas instead.

Or Houston to Dallas. There's no train between the two.

by David C on Aug 20, 2013 2:30 pm • link • report

Or my apartment to my office. Feel free.

by drumz on Aug 20, 2013 2:34 pm • link • report

It is amazing to me how much effort people put into explaining why something can't be done, instead of putting that effort into solving any problems that might be preventing it from being a reality. Truly amazing. No wonder true innovation comes from so few individuals.

The reason the hyperloop proposal gets this reaction is because the media likes to slobber all over these proposals that provide very little facts to back up their cost assumptions, while continuously trashing transit and high-speed rail projects that use actual existing technologies with actual, factual cost estimates backing them up.

It would be great if Musk can build a transportation system for $6b that can get people from LA to SF in 30 minutes and costs $20 a ticket. But you know the old adage, "if it sounds too good to be true, it probably is." There are multiple issues that pop out to anyone with knowledge about how transportation works. Matt has pointed out a few. Alon Levy pointed out a whole other set that someone with more expertise notices. Every one of your solutions to those problems raises the $6b cost and $20 ticket cost. You can't just start tacking on more and more and then claim that there's still a huge cost savings to be had over other options.

And on the capacity point, you could build pylons that could handle 4 or 6 tubes for a marginally increased initial cost, and then add subsequent tubes later.

Exactly the kind of hand-waving about costs that pisses people off. You're gonna build 2-3x the infrastructure and the cost increase will be "marginal"? OK.

by MLD on Aug 20, 2013 2:55 pm • link • report

The Space Shuttle was not a worthwhile endeavor. And I used to work on it.

Oh, snap!

by BTA on Aug 20, 2013 2:56 pm • link • report

"The reason the hyperloop proposal gets this reaction is because the media likes to slobber all over these proposals that provide very little facts to back up their cost assumptions, while continuously trashing transit and high-speed rail projects that use actual existing technologies with actual, factual cost estimates backing them up."

To be fair though, the media does this with other issues too.

"lets seperate out C02 at smokestacks and then bury it in deep mines = YAY! Lets use more efficient light bulbs = BOO!"

by AWalkerInTheCity on Aug 20, 2013 3:02 pm • link • report

To be fair though, the media does this with other issues too.

Yes, they like anything that replaces realistic difficult decision-making with fantasy future-tech that will save us all!

by MLD on Aug 20, 2013 3:06 pm • link • report

"It is the only private company currently launching round-trips to the space station."

They're not even doing that. True they're the only private company with downmass capability, but "round trip" implies more than "brings back old experiments."

by Another Nick on Aug 21, 2013 4:25 pm • link • report

[*This comment has been deleted for violating the comment policy.*]

by John C. on Aug 26, 2013 7:51 am • link • report

The Hyperloop is an exciting idea for fast distance travel, but similar to current public transportation options like California's Silicon Valley light rail system or Caltrain commuter train system, it relies on the public to travel to and from a designated train stop. If one were to use our BiModal Glideway system you'd be able to travel from door to door without relying on changing trains, busses or leaving your car in a crowded commuter parking lot during the day where it could be vandalized. Visit our website for a short video description and more information about the BiModal Glideway and leave us your comments or questions about our system. We can also be found on Facebook, Twitter and LinkedIn.

by Tony Alvarado on Oct 9, 2013 12:27 pm • link • report

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if its not a political donor kickback, bankruptcy artist plan, it will inculde an indebth study of economic justification, identifying the variables, with a proforma profit and loss statement, above the level of thinkng elon and his back er baracck is capable of

by jackie on Oct 11, 2013 10:17 pm • link • report

Firstly, just because it may or may not work in the United States doesn't mean it won't work elsewhere. The UK, for example, has none of the problems in devolution of power and so has no political problems. The Monarch, which in reality means the Prime Minister, can seize and any all land s/he wants at any cost s/he wants to pay. In reality, market rate would be paid - but no special interests would be needed to be served.

Secondly, maximum passenger capacity is not necessarily an issue. If technologically possible (and the economics might mean it has to be) to have 800 seater cars (standard capacity of London Underground trains), then 45 trains an hour (about the same as the London Underground) is about right. This would give plenty of time for stopping distance - not to mention the possibility of creating a stopping / emergency tunnel which was adjacent to the main service tunnel. Nor does it exclude the possibility of air vents, letting in air to slow it down in emergency situations.

Further, while you would only need 2/maybe 3 tunnels for the route, you could have 30, 50, or 100 at a station - allowing for these pods to split off to different platforms, each fitted with their own airlock systems.

by Joshua Burge on Jul 10, 2014 7:15 pm • link • report